

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR

Howard P. Doub, M.D.
Detroit, Michigan



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JANUARY, 1955

No. 1

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No. 1

Principles of Supervoltage (2 Million Volts) Rotation Therapy

Illustrated by the Treatment of a Chordoma of the Vertebra¹

MILTON FRIEDMAN, M.D., GERALD J. HINE, Ph.D., and JOSEPH DRESNER, M.S.

THE EFFICIENCY of a particular form of radiation therapy is gauged by its ability to produce rather homogeneous dose distribution within the tumor region with minimal irradiation of the surrounding tissues. Supervoltage rotation therapy with 2 Mv x-rays has been found by Trump, Hare, and associates (1, 2) to produce efficient dose distributions.

The principles and special advantages of supervoltage rotation therapy will be illustrated by the report of a case of chordoma of the body of the fourth lumbar vertebra. The therapeutic problem was to deliver a large tumor-lethal dose of radiation (approximately 7,000 r) to a deep-seated lesion which lay not only near the center of the torso but also close to the cauda equina.

CASE REPORT

W. T. H., a white male aged 44 years, in June 1952 suddenly experienced sharp pain in the lumbar region and posterior right thigh, interfering with locomotion. Radiographic examination (Fig. 1) disclosed an osteolytic tumor of the anterior and right half of the body of the fourth lumbar vertebra. There was perforation of the cortex of the bone, with lateral extension of the disease into the soft tissues.

On Sept. 4, 1952, through a right transverse flank

incision, the vertebra was exposed retroperitoneally. A biopsy needle removed some grayish, jelly-like tissue, which was diagnosed histologically (by Dr. Henry L. Jaffe) as "chordoma" (Fig. 2).

The therapeutic problem is illustrated in Figure 3. The tumor, measuring 4 cm. in diameter, lay 1 cm. from the cauda equina, the tolerance dose for which is 5,000 r in five to eight weeks. The anterior border of the tumor was 3 cm. from the intestines, whose tolerance dose is 4,500 r in a like period. It was deemed necessary, on the basis of our previous experience, to deliver to this tumor a dose of approximately 7,000 r.²

From Nov. 20, 1952, to Jan. 6, 1953, twenty-six x-ray treatments were given with a two-million-volt resonant transformer generator. With rotation technic, a tumor dose of 7,200 r was delivered in forty-seven days to a cylindrical volume of tissue measuring 6 cm. in diameter and 6 cm. high, which encompassed the tumor. The dose to the spinal cord ranged from 3,800 to 4,400 r. At the conclusion of treatment, the pain had disappeared. Radiographic examination one month later showed healing sclerosis of the lesion and restoration of normal contour of the body of the vertebra (Fig. 4). This remains unchanged to date (December 1954). There was no erythema of the skin and no evidence of spinal cord damage two years after irradiation.

The therapeutic problems in the above case are typical of those which can be efficiently solved by means of supervoltage rotation therapy. Before describing the technic employed at the Hospital for

¹ From the Lila Motley Radiation Therapy Department, Hospital for Joint Diseases, New York, N. Y. Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13-18, 1953.

² Baker and Coley (3) recently reported a chordoma of a lumbar vertebra with primary healing following a tumor dose of 4,000 r in less than thirty days. They employed one-million-volt x-rays delivered through three portals.

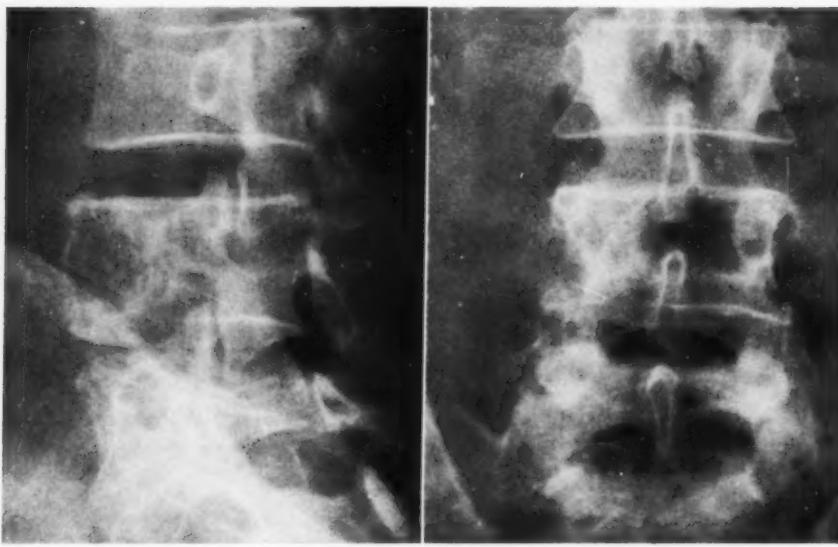


Fig. 1. Chordoma of the fourth lumbar vertebra. The osteolytic area involves the anterior and right half of the body of the vertebra and extends laterally into the soft tissues. There is slight reactive sclerosis.

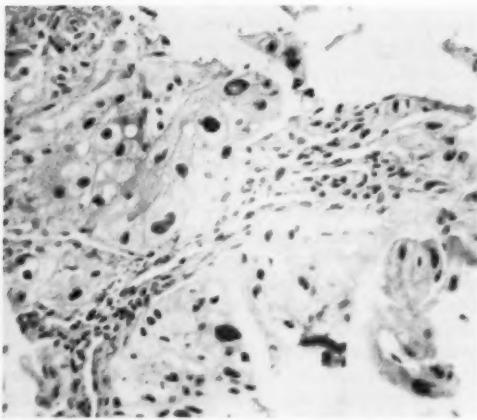


Fig. 2. Photomicrograph of tissue from the fourth lumbar vertebra, showing typical chordoma.

Joint Diseases, let us consider the treatment of the above chordoma by other methods.

NON-ROTATION TREATMENT TECHNIQUES

The dangers of supervoltage irradiation with a single portal or two opposing portals have been previously discussed (4). Multiple portal techniques are safer. Figure 5 illustrates four opposing portals aligned

along two axes and cross-firing a hypothetical tumor. Only in a phantom, however, can four beams be so accurately aligned; such accuracy is rarely obtained in clinical practice. A relatively homogeneous tumor dose has been achieved, but the dose level within the columns of normal tissue traversed by the beams is significantly high (approximately one-half that of the tumor dose). Thus portions of the intestines would be heavily irradiated.

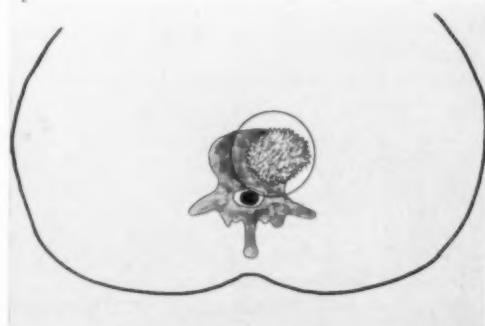


Fig. 3. Cross-section diagram of patient, illustrating the location of the chordoma and its proximity to the cauda equina and intestines. The circle outlines the area to be treated.

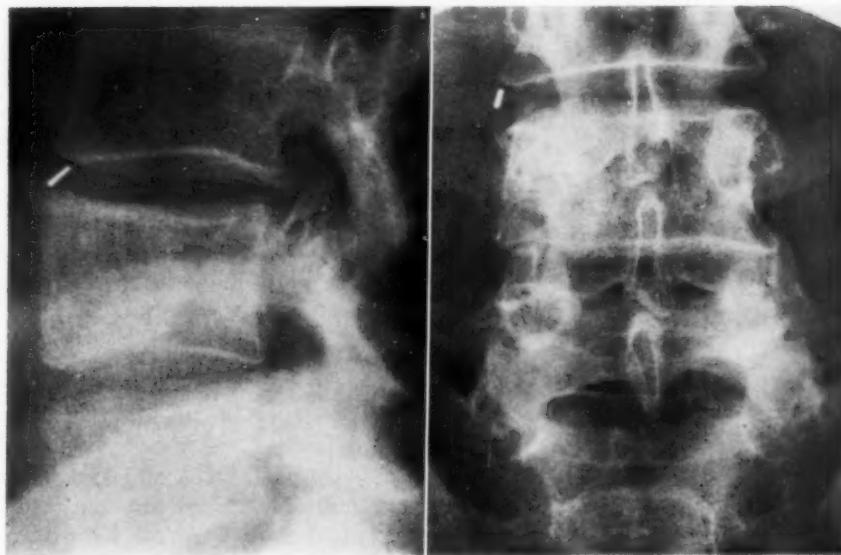


Fig. 4. Healed chordoma one month after a tumor dose of 7,200 r in forty-seven days. The rapidity of healing sclerosis is indicative of the effectiveness of the irradiation.

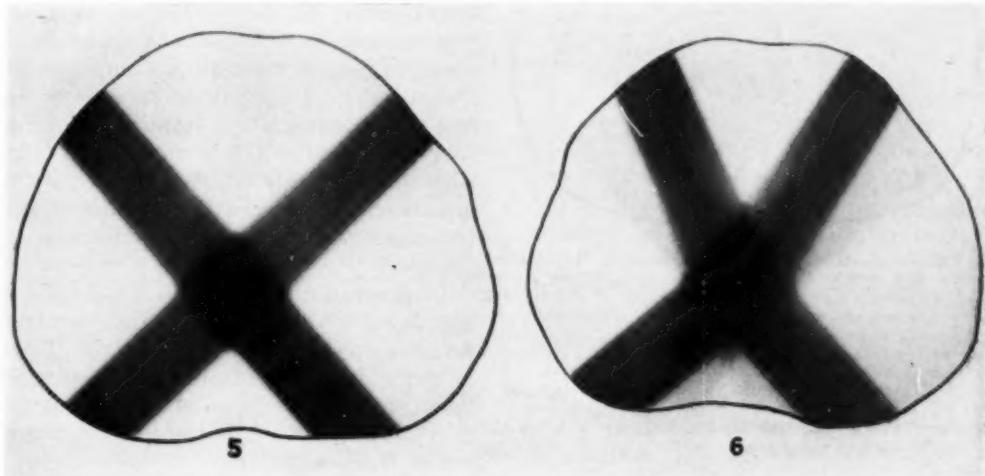


Fig. 5. Hypothetical treatment of a chordoma with four opposing portals, accurately aligned along two axes. This accuracy of beam-aiming was obtained experimentally with great difficulty and cannot be achieved in clinical practice.

Fig. 6. Hypothetical treatment of a chordoma with four portals designed to avoid overlapping of the incident and exit columns of radiation. Compared with Fig. 5, the concentration of radiation in normal tissues is reduced, but the homogeneity within the tumor is also reduced.

Theoretically, the spinal cord could be spared. However, even with elaborate beam-aiming devices, the daily precise reproduction of the same settings with multiple portals can hardly be achieved, particularly with small fields.

Figure 6 illustrates a four-portal technic designed to avoid overlapping of the incident and exit columns of radiation. Here the dose in normal tissues is diluted, but with some sacrifice of homogeneity of dose distribution throughout the tumor. In

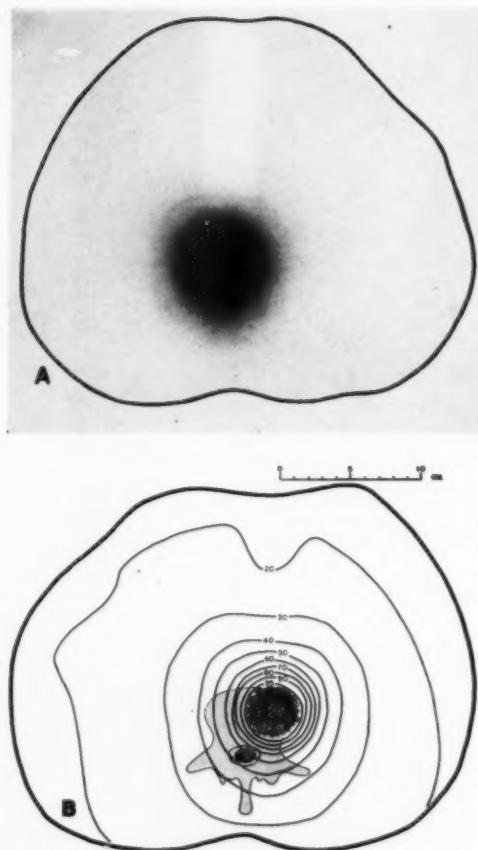


Fig. 7. A. Distribution of radiation in the treatment of a chordoma of the 4th lumbar vertebra with 2-Mv rotation therapy. The darkening of the x-ray film, exposed in a phantom to radiation of this energy, is directly proportional to the dose. The lighter streak at the top is the shadow cast by the supporting column on the rotation platform.

B. Isodose curves taken from the film illustrated in Fig. 7A by densitometry. This dose distribution is typical for a medium-size (6 cm. diameter) irradiated cylinder in a central location.

clinical practice, small errors in beam aiming are difficult to avoid, particularly with narrow beams which aggravate the inhomogeneities.

More than four portals may be employed to dilute further the concentration of radiation in normal tissues and to increase slightly the homogeneity within the tumor area. This, however, is not only time-consuming but increases the frequency of errors in beam-aiming.

SUPERVOLTAGE ROTATION THERAPY

The above difficulties are materially reduced when rotation technics are employed with supervoltage radiation. There is not only homogeneous distribution of radiation within the desired volume, but also a rapid fall-off in dosage outside this volume (Fig. 7). Instead of treating through six to fourteen different fields on a patient, only one setting is required and this is accomplished with facility and a high degree of accuracy.

Before discussing the principles of rotation treatment technic, certain physical factors of supervoltage rotation will be evaluated.

Roentgen Flux at Axis of Rotation: The two-million-volt resonant transformer, previously described (4), has a roentgen flux of 108 r/min. at a distance of 1 meter when an added filter of 4 mm. lead is employed. This high output permits the use of a long target-tumor distance—125 cm.—for rotation therapy, with a resultant reduction in roentgen flux at the axis of rotation to 70 r/min. (air). Under these conditions the free space between the front plate of the tube-head and the axis of rotation is 78 cm. This space permits rotation of the patient in centric or eccentric positions and accommodates various beam direction devices.

In general, the r/min. in the tumor is approximately one-half of the roentgen flux in air at the center of rotation. Thus, a treatment time of six to ten minutes delivers a tumor dose of approximately 200 to 350 r, which is the range of daily tumor dose employed.

If the roentgen output were considerably lower at the center of rotation, the prolonged treatment time would materially reduce the number of patients treated each day. At our installation, during eight hours of operation, from 32 to 34 patients are irradiated. Three-fourths of these receive rotation therapy and one-fourth are treated with conventional technics.

Effect of Radiation Quality on Rotation Therapy: Three different x-ray energies have been employed for rotation therapy:

200 kv as used by Nielsen (5, 6); 2-Mv x-rays by the authors and Trump *et al.* (1, 2); and 22-Mv x-rays by Laughlin *et al.* (7).

The dose distribution for these energies was studied by rotating a tissue-equivalent cylindrical phantom about its vertical axis. A narrow horizontal beam of x-rays, 3 cm. wide, was directed at the axis (see insert of Fig. 8). The resultant dose distributions

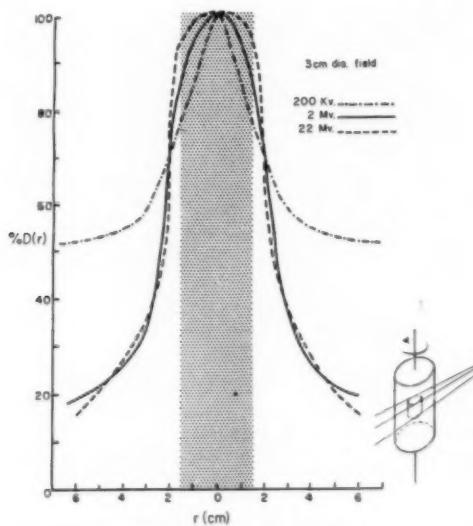


Fig. 8. Comparison of dose distribution in rotation therapy with three x-ray energies. The 3 cm. diameter irradiated cylinder inside a 30 cm. diameter phantom is represented by the shaded area in the graph. The abscissa represents the distance (r) from the axis of rotation; the ordinate is the percentage of the central axis dose. Under these conditions the dose distribution for 2 Mv is practically the same as for 22 Mv.

are compared in Figure 8, where the dose at the center of the tumor is the same for all energies. It is seen that for this small 3 cm. diameter field, the dose distribution for 2 Mv is practically the same as for 22 Mv. This is true not only for the homogeneous high-dosage region within the tumor, but also the low-dosage region outside the tumor area. The results with 200-kv x-rays are much less satisfactory, the volume dose outside the tumor being twice as high as for supervoltage radiation.

For large fields, in the supervoltage range, the dose distribution inside the

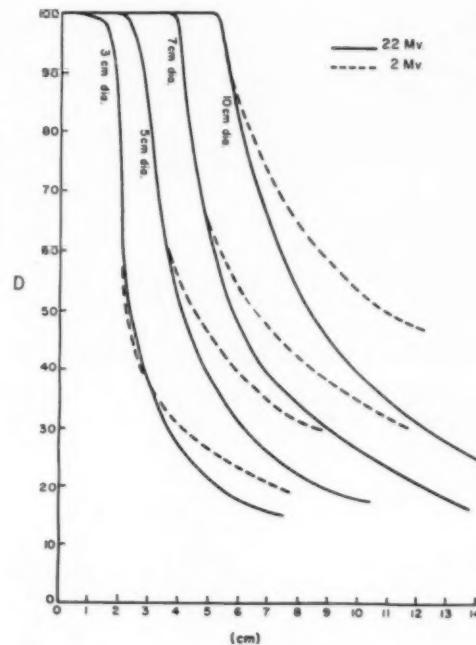


Fig. 9. Comparison of dose distribution in rotation therapy between 2-Mv and 22-Mv x-rays for different field sizes. The percentage of the maximum tumor dose (ordinate) is plotted as a function of the distance from the axis of rotation (abscissa).

Within the tumor region, the dose distribution is the same for 2 Mv as for 22 Mv. In the surrounding normal tissues, the dose distribution is essentially the same when narrow beams are employed; for large field sizes, the higher energy results in a slightly reduced volume dose.

tumor region is independent of the actual voltage (Fig. 9). In the surrounding normal tissues, however, the dose becomes reduced as the voltage rises from 2 to 22 Mv. For example, when irradiating a cylinder of 7 cm. diameter in the center of a phantom of 30 cm. diameter, the dose in the normal tissues near the periphery (12 cm. from the axis of rotation) is decreased from 33 to 23 per cent of the maximum tumor dose. Therefore, when rotation techniques are employed with high-energy x-rays, an increase in energy from 2 to 22 Mv serves only to reduce slightly the volume dose to surrounding normal tissues.

What is the relative efficiency of 200-kv rotation therapy as compared with 2,000-kv rotation therapy? This can be estimated by comparing the central tumor

dose with the *skin* dose. For a field size of 6 cm. diameter as used in the chordoma in the reported case, this ratio for 200-kv radiation is approximately 2:1 whereas for 2,000-kv radiation, it is approximately 8:1. Clinically this means that, for a tumor dose of 7,000 r with 200-kv radiation, the skin would receive 3,500 r, result-

small, such as a 3×3 cm. field for pituitary adenoma (Fig. 10), rotation therapy with supervoltage radiation attains the ideal goal of radiation therapy.

As the size of the irradiated volume increases, the amount of radiation absorbed outside the tumor becomes higher (Fig. 9). This can be seen by comparing Figure 10

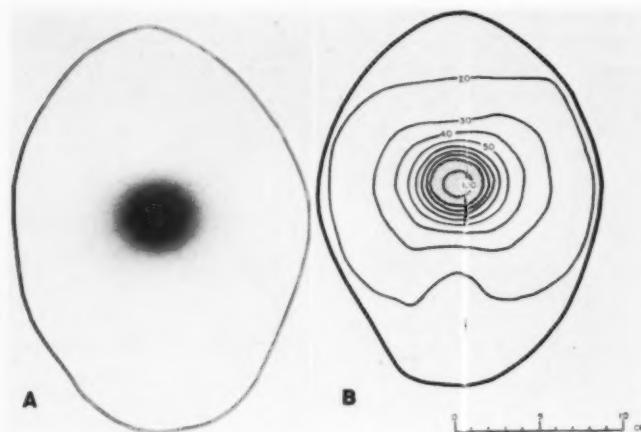


Fig. 10. A. Distribution of radiation when a pituitary adenoma is treated by 2-Mv rotation therapy, with a small field, 3 cm. in diameter.
B. Isodose curves taken from the film in Fig. 10 A by densitometry. For a tumor dose of 6,000 r the skin would receive less than 1,200 r.

ing in a severe erythema. All the tissues between the skin and the tumor would be more heavily irradiated. With 2,000 kv, the skin dose would be approximately 900 r. Consequently, with 200-kv radiation, an attempt to deliver such large tumor doses as 7,000 r to regions inside the torso can hardly be undertaken. On the other hand, supervoltage rotation therapy produces relatively mild skin and volume dose effects and makes possible the administration of large doses to deeply seated tumors, within a large cross section. For smaller cross sections, such as head, neck, and extremities, for segmental rotation of subsurface lesions, and for a narrow treatment field, such as 2.7 cm. width for carcinoma of the esophagus (5), 200-kv rotation therapy becomes relatively less inefficient.

Role of Field Size: When the field size, and consequently the irradiated volume, is

(3 cm. diameter volume for pituitary adenoma) with Figure 7 (6 cm. diameter volume for chordoma of the vertebra) and with Figure 11 (15 cm. diameter volume for carcinoma of the cervix). In the last, note the heavy irradiation of the surrounding normal tissues. When the irradiated area is relatively large compared with the area of the body cross section, the volume dose to the normal tissues will be large, and the superiority of rotation technic over multiple-portal technic is reduced.

The Rotating Platform: The rotating platform follows the basic design used by Trump and Hare.³ The patient is rigidly immobilized in either the standing (Fig. 12A) or sitting (Fig. 12B) position. The platform turns at the comfortable rate of

³ This rotating platform was constructed by the High Voltage Engineering Corporation, Cambridge, Massachusetts.

about one revolution per minute. The fact of six to ten revolutions per daily treatment renders unnecessary the careful notation of the position of the platform at the beginning and end of each treatment.

There is provision for a couch, whereby the patient can be rotated horizontally, but clinical experience has proved vertical axis rotation to be satisfactory for nearly all lesions. Furthermore the cylindrical or

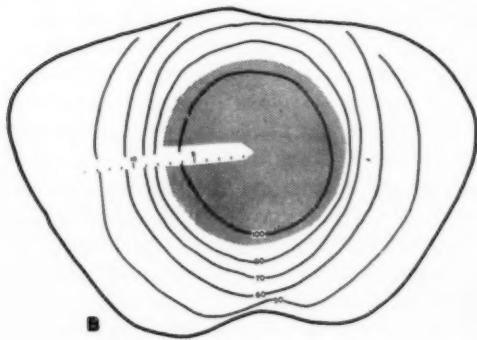
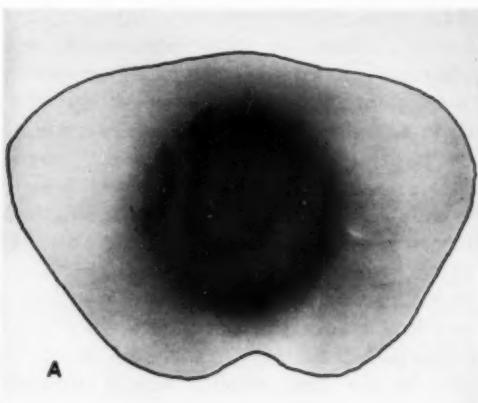


Fig. 11. A. Distribution of radiation when an extensive carcinoma of the cervix receives 2-Mv rotation therapy using a 15 cm. diameter field. When the irradiated area is relatively large with respect to the cross-section area, the efficiency of rotation technic is reduced because of the increased volume dose in normal tissues.

A ring of increased density at the edge of the irradiated cylinder appears when large fields are used. This is due to the reduced absorption occurring when the perimeter of a large field lies close to the surface of the phantom.

B. Isodose curves taken from the film in Fig. 11A by densitometry. The increased density of the peripheral ring is 5 per cent greater than the central area and is not represented by an isodose curve. For a tumor dose of 6,000 r, the skin dose would range from 2,400 to 3,000 r.

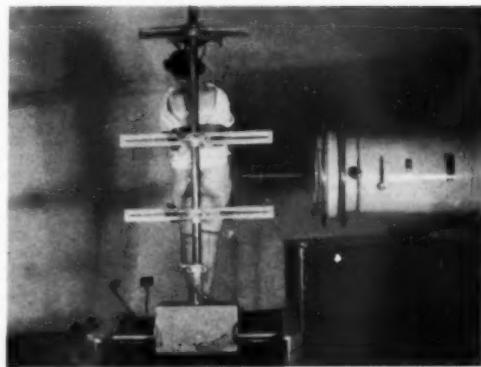


Fig. 12A. Patient in standing position for rotation therapy of a carcinoma of the cervix. In the upper view, note alignment of spinal column with the vertical support of the platform. The Dresner pointer touches a reference mark on the lateral right hip. This lateral mark is used for obese patients whose abdominal wall can change position from day to day. The lower view illustrates the pointer touching a reference mark in the suprapubic region. Note the versatile adjustments to hold the patient rigidly.

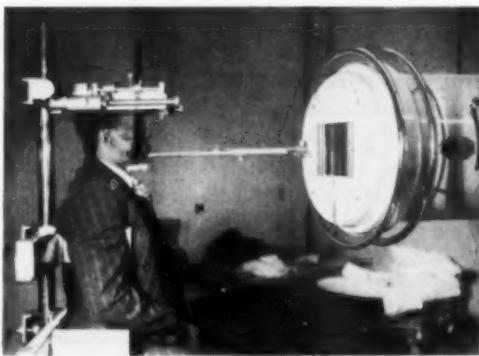


Fig. 12B. Patient in sitting position for rotation therapy of carcinoma of the tonsil. Note the pointer in contact with the reference point on the skin of the chin.

TABLE I: MAGNITUDE OF ERROR RESULTING FROM INACCURATE BEAM ALIGNMENT

Error*	Field 3 cm. wide		Field 5 cm. wide		Field 7 cm. wide		Field 10 cm. wide	
	0.5 cm.	1 cm.	0.5 cm.	1 cm.	0.5 cm.	1 cm.	0.5 cm.	1 cm.
Volume receiving full dose	45%	11%	64%	36%	73%	51%	81%	64%
Total volume irradiated	178%	278%	144%	196%	130%	165%	121%	144%

* Error = displacement of x-ray beam from axis of rotation.



Fig. 13. Inhomogeneous dose distribution resulting when an x-ray beam is improperly aligned with respect to the axis of the rotating platform. This 5 cm. diameter beam was displaced 1 cm. As a result, the volume receiving the calculated tumor dose was reduced to 36 per cent, and the total volume irradiated was increased by 96 per cent; the peripheral region was underdosed.

spherical volume of irradiated tissue so obtained approximates the shape of the tumors more satisfactorily than the conical isodose distribution obtained when the patient is horizontal and rotates about a vertical axis.

Alignment of X-Ray Beam with Axis of Rotation: Rotation therapy requires that the central axis of the x-ray beam and the center of the tumor coincide precisely with the axis of rotation. Otherwise, serious errors in treatment result. Figure 13 illustrates rotation with a beam of 5 cm. diameter, whose central axis was displaced 1 cm. The volume receiving the calculated tumor dose was reduced to 36 per cent, the total volume irradiated was increased by 96 per cent, and the peripheral region was underdosed. As indicated in Table I, these errors are of considerable magnitude for small fields and less for large fields.

Localization of the Tumor in the Patient: The center of the tumor must be accurately located and its position oriented with respect to one fixed point on the skin in a horizontal plane passing through the tumor. There are numerous clinical and laboratory methods for locating the center of a tumor in each part of the body; and there are several technics for determining the position of the "reference point" on the skin.

Only the technic employed for "patient rotating, beam horizontal" (see Appendix) will be described here. The chordoma mentioned at the beginning of this paper was first localized by conventional radiography. A lead marker was placed on the skin in the right lumbar region, approximately over the tumor, and a new radiograph was taken with the patient erect. For this purpose, the central axis of the x-ray beam was accurately placed in the same horizontal plane as the lead marker. On the basis of the resultant film, the position of the lead marker was corrected, when necessary, so as to overlie the center of the tumor. The corrected central point of the tumor in this case was ascertained to be 1.5 cm. to the right of the mid-line at the level of the 4th lumbar vertebra. This "reference mark" was painted on the skin. The height of this mark from the floor, with the patient barefoot, was recorded as 105.5 cm.

The next step was to ascertain the depth of the center of the tumor from the reference mark on the skin. The contour of the body at this level was drawn with the aid of a contour device illustrated in Figure 14A, where it is being employed for a carcinoma of the cervix. The device is attached to vertical supports in such fashion that it can be fixed in a horizontal position at any height. After the spokes are adjusted, the

contour-meter is unhinged to release the patient and is transported to a drawing table, where a tracing of the contour is made (Fig. 14B).

In the case of the chordoma of the vertebra, the center of the tumor was oriented with respect to the anterior surface of the vertebra with the aid of radiographs. From tables constructed by Friedman (9), it was determined that the center of the tumor was 8.8 cm. deep from the designated reference point on the skin. This point was marked on the contour sheet and the vertebra and tumor were sketched (Fig. 3).

In order to plan the treatment, this drawing was now studied. Because of the central location of the tumor it was elected to employ 360° rotation, and to irradiate a cylindrical volume, 6 cm. in diameter and 6 cm. high.

Treatment planning was now completed. The geometrical data were documented and available for dose calculations. The reference point for centering the tumor was painted on the skin.

Calculation of the Tumor Dose: The tumor dose is calculated by graphical summation. The cross section is divided into twelve equal sectors by lines which intersect at the center of the tumor. There are now twelve radii. The length of each radius is measured, and the percentage tumor dose for each radius ascertained from charts, specially prepared by Trump and his associates for 2-Mv x-ray rotation therapy. The twelve percentage tumor doses are then averaged. The resultant figure represents the tumor dose (with back-scatter) in per cent of the air dose at the axis of rotation. In the case of the chordoma, the average tumor dose was 50 per cent. Since the roentgen flux (in air) at the axis of rotation was 70 r/min., the tumor dose per minute was 35 r. Thus, a daily exposure of eight minutes delivered a daily tumor dose of 280 r.

Positioning the Tumor at Center of Rotation, Using the Right-Angle Co-ordinate System: The next step consists in positioning the patient on the platform so that

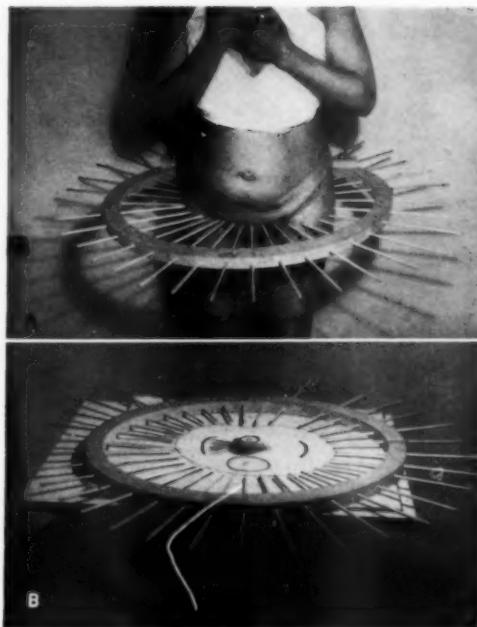


Fig. 14. A. Contour-meter being employed to outline the pelvis. It is maintained in horizontal position by clamps attached to two vertical rods fixed to the wall. It is hinged on one side to release the patient.

B. Contour-meter removed from clamps and placed on drawing table. The outline of the pelvis is drawn. The relative position of the tumor and normal structures has been ascertained by clinical and radiographic means.

the rotating tumor always remains in the x-ray beam. The right-angle coordinate system, introduced by Trump *et al.* (1), has been refined with the aid of the contour meter and the Dresner pointer (8). It is a simple method for achieving a high degree of accuracy in setting up a patient within a few minutes.

The technic is illustrated by the treatment of a chordoma, as shown in Figures 15, 16, 17, and 18.

The position of the tumor and its depth from the skin along the anteroposterior axis of the body have been determined as described above. The rotating platform is turned to the zero position, so that the traverses on which the supporting column and its crossbars are mounted can be moved parallel to and perpendicular to the x-ray beam (Fig. 15).

The patient is fixed either in sitting or

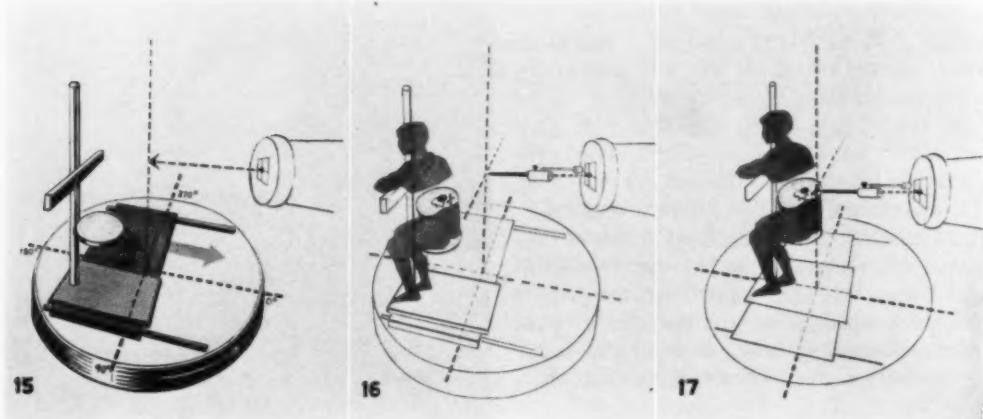


Fig. 15. The platform is turned to the zero position. Its horizontal supporting cross-bars are perpendicular to the x-ray beam. The cross-bars move only in directions perpendicular and parallel to the x-ray beams.

Fig. 16. The patient is firmly positioned so that his lateral axis is parallel to that of the cross-bar. The Dresner pointer is in zero position. Its tip is at the axis of rotation, which is 125 cm. from the target.

Fig. 17. The patient is shifted so that the identifying skin mark touches the pointer. The tumor lies in the axis of the x-ray beam, but is 8.8 cm. distal to the center of rotation. The lateral traverse is now locked in position.

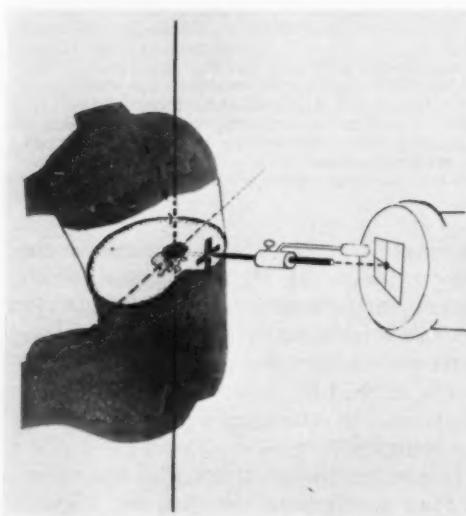


Fig. 18. The pointer is retracted 8.8 cm. The patient is moved toward the tube face so that once again the pointer touches the identifying skin mark. The tumor now lies in the center of rotation.

standing position on the platform. He usually faces the x-ray machine, with his spinal column aligned with the supporting column of the platform (Fig. 12A). For the irradiation of the chordoma, he is seated with his back to the x-ray machine and his ventral mid-line aligned with the support-

ing column. His lateral axis is perpendicular to the x-ray beam (Fig. 16). The pointer is brought into position so that its tip intersects the axis of rotation at 125 cm. from the target.

The patient is shifted by moving the traverses until the reference mark on the skin touches the pointer (Fig. 17). The center of the tumor now lies in the axis of the x-ray beam but is 8.8 cm. anterior to the center of rotation. The lateral traverse is locked in position.

For the final step, the pointer is retracted 8.8 cm., and the patient is shifted until the pointer again touches the identifying skin mark (Fig. 18). The center of the tumor now coincides with the center of rotation. The other traverse is locked in position, and the patient is in readiness for rotation therapy.

Radiographic corroboration with the 2-Mv x-ray is employed wherever possible. It was of no value for the chordoma because of the absence of contrast between the different tissues. It is extremely useful in many other situations, where air cavities serve as contrast media: lung, pharynx, and bladder into which a Foley bag is inserted and inflated with air.

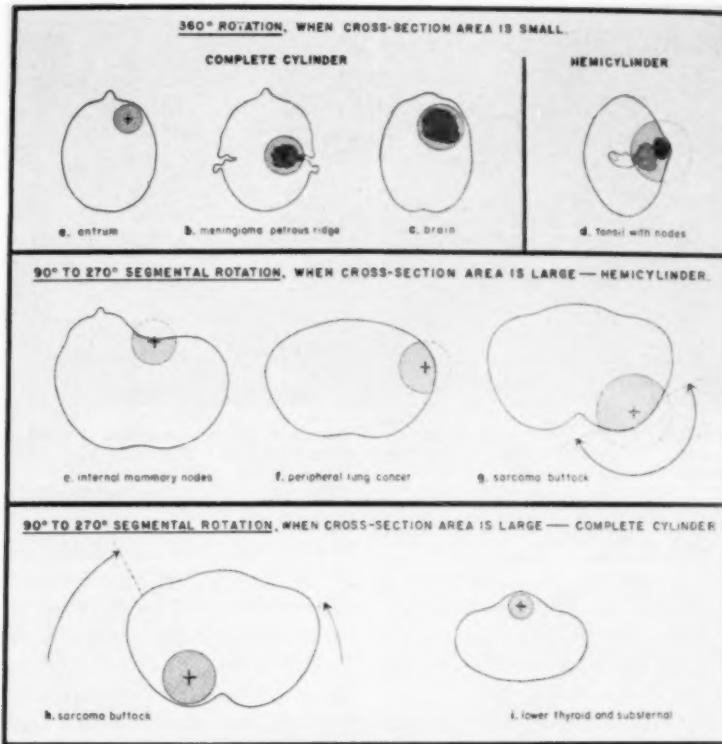


Fig. 19. Examples of different methods of employing supervoltage rotation therapy to meet the geometrical requirements of certain tumors situated near the surface of the body.

ROTATION TECHNICS FOR TUMORS NEAR THE SURFACE

Supervoltage rotation therapy is superior to conventional 250-kv radiation for deeply seated tumors. In addition, it offers advantages for certain tumors near the skin.

Figure 19 illustrates nine examples of subsurface lesions for which supervoltage rotation therapy was applied. Special geometrical requirements were fulfilled in different ways.

When the cross section area is small, as in the head and neck, 360° rotation can be employed, as the total volume dose remains small (Fig. 19a, b, c). If the lesions are laterally located, they can be incorporated within a complete cylinder of irradiation (Fig. 19a), or within a hemicylinder of larger diameter, to include not



Fig. 20. Healed skin of right face three months after a tumor dose of 10,000 r in thirty days for a carcinoma of the antrum. See Fig. 19a for treatment technic. The skin has remained unchanged for two years.



Fig. 21. Skin reactions of a patient with carcinoma of the tonsil. The tumor dose of 9,050 r in twenty-nine days was delivered to a hemicylinder, 9 cm. diameter and 10 cm. high. A. Three days after completion of treatment. B. Four months later. See Fig. 19d for technic of treatment.

only the demonstrable tumor but a larger lymph node region (Fig. 19d).

When the cross-section area is large, as in the chest, abdomen, and pelvis, it is important to minimize the irradiation of normal tissues. This is achieved by utilizing a portion of the irradiated cylinder, or by segmental rotation through arcs ranging from 90 to 270° (Fig. 19e, f, g). Segmental rotation reduces the homogeneity of dose distribution in the tumor volume. The smaller the arc of scanning, the less is the homogeneity.

The advantages of supervoltage rotation therapy for subsurface lesions are illustrated by the following examples. Figure 20 depicts the skin of a patient three months after a tumor dose of 10,000 r in thirty days for a carcinoma of the right antrum. The irradiation was delivered to a cylinder 5 cm. in diameter and 4 cm. high (see Fig. 19a). The tumor disappeared. The only early reactions were a faint erythema and slight lacrimation of the homolateral eye. Complete 360° rotation was employed because the small cross-section area resulted in a small volume dose, and because no important normal structure was compromised.

Figure 21 illustrates the skin reactions of a patient treated according to the diagram in Figure 19d, for a large carcinoma of the tonsil with marked infiltration of the deeper

tissues, causing earache and pain in the side of the head. One metastatic node measured 2.5 × 4.5 cm. A tumor dose of 9,050 r in twenty-nine days was given in April 1953 to a hemicylinder 9 cm. in diameter and 10 cm. high. Figure 21A depicts the skin three days after the last treatment, and Figure 21B four months later. At the height of the reaction, there was unilateral second-degree epithelitis, causing only slight discomfort. The tumor disappeared. Supervoltage rotation therapy permitted the administration of 9,050 r *homogeneously* to the primary tumor as well as to palpable and deep-seated, impalpable metastatic nodes.

The sharp delineation of irradiation in the tumor volume is best demonstrated by observing mucous membrane reactions. In another patient, with a tumor of the nasal cavity and palate, 360° rotation was used. The tongue was included in the irradiated volume. On the eighteenth day of treatment, when the tumor dose was 4,500 r, the reaction on the surface of the tongue was found to coincide with the predetermined location of the irradiated volume, having the center of rotation 1 cm. to the right of the mid-line (Fig. 22). This confirmed the accuracy of the treatment procedure described previously.

A final example of the treatment of subsurface tumors is illustrated in Figure 23A,

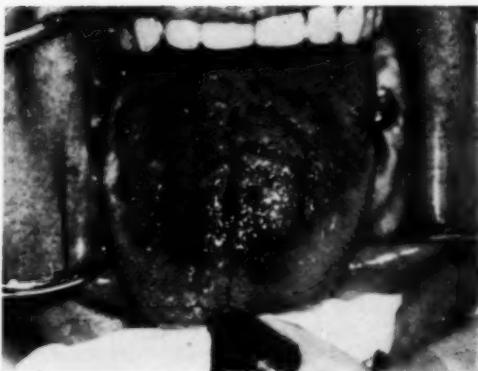


Fig. 22. Mucous membrane reaction on the tongue outlining the irradiated volume. The tumor of the nasal cavity and palate was irradiated by 360° rotation, with the center of rotation 1 cm. to the right of the mid-line. This type of observation of mucous membrane reactions corroborates accuracy of beam-aiming.

taken six months after irradiation. The patient had a liposarcoma of the buttock, with postoperative residuals. Oscillating rotation through a 270° arc was employed, as illustrated in Figure 19*h*, in order to minimize irradiation of the intestines. The tumor dose of 9,000 r in thirty-one days was delivered to a cylindrical volume 10 cm. in diameter and 10 cm. high. The early skin reaction was a moderate first-degree erythema. Eighteen months after irradiation, there was a circumscribed fibrous mass (Fig. 23*B*) approximately the size of the treated volume, and not adherent to underlying bone.

These cases exemplify the ability of supervoltage rotation therapy to deliver large doses of radiation to well defined, predetermined volumes of tissue, with minimal effects on normal tissues. The tumor doses were much greater than could be safely administered by conventional techniques.

SUMMARY AND CONCLUSIONS

1. Rotation techniques with supervoltage x-rays constitute an important advance in radiation therapy. They permit homogeneous irradiation of a tumor with high dosage, while the volume dose to normal tissues remains small. As a result, it is possible to deliver, with safety, lethal

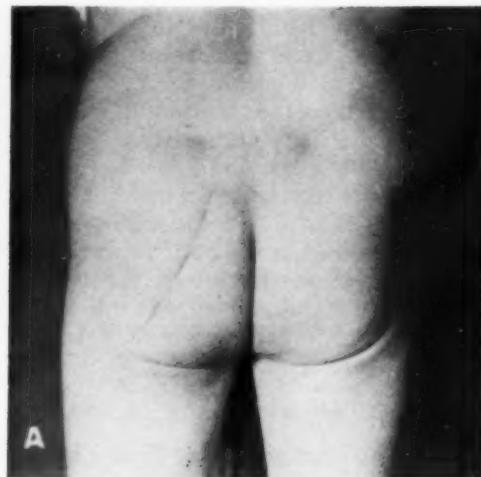


Fig. 23. A. Minimal radiation changes in the left buttock six months after a tumor dose of 9,000 r in thirty-one days to a cylindrical volume, 10 cm. diameter and 10 cm. high.

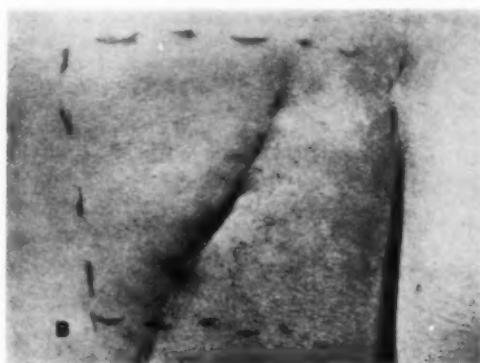


Fig. 23B. Eighteen months after irradiation. There is a circumscribed fibrous mass approximately the size of the irradiated volume but not adherent to underlying bone.

tumor doses to certain deep-seated neoplasms which could not be efficiently irradiated with the use of conventional techniques.

2. In the supervoltage range of 2 to 22 MV, the dose distribution in the tumor and adjacent normal tissues is independent of the voltage when small fields are employed. For large fields, the higher voltage decreases slightly the volume dose to the normal tissues, while the doses to the tumor region remain the same.

3. The "right-angle co-ordinate sys-

tem" for positioning the tumor at the center of rotation is an accurate and easily reproducible method for precision irradiation. It requires a horizontal contourmeter, a rotating platform with two perpendicular traverses, and a special pointer. Radiographic corroboration with the treatment beam is employed wherever feasible.

4. Variations of the basic supervoltage rotation principles have been successfully employed for treatment of subsurface lesions, particularly tumors of the head and neck.

APPENDIX

Types of Rotation or Moving Field Therapy

The purpose of this appendix is to attempt to clarify and classify the various types of rotation or moving field therapy. Difficulties in terminology arise from the fact that the patient as well as the radiation source can rotate. The patient can be rotated in several positions and the angle of incidence of the radiation beam on the body can be varied. The radiation source can revolve or oscillate in many fashions. Different combinations of these factors can result in the same or in different patterns of dose distribution.

There are two basic patterns of radiation distribution: (1) cylindrical (or spherical) and (2) conical.

- 1a. *Patient rotating, beam horizontal:* The x-ray beam is in a plane perpendicular to the long axis of the patient, who is standing or sitting on a rotating platform. This type of rotation is described in this paper.
- 1b. *Patient horizontal, beam rotating:* The x-ray beam moves in a plane perpendicular to the long axis of the patient, who is fixed in a horizontal position. This principle can be employed with cobalt teletherapy units and x-ray machines.

The above two techniques result in identical dose distributions. The isodose surfaces form a series of concentric cylinders or spheres.

- 2a. *Spiral convergent beam rotation:* The moving x-ray beam always lies in a solid cone whose apex is directed at a fixed point in the tumor, and it describes a spiral path on a spherical sector during treatment. This type of rotation

therapy is performed by a special 200-kv x-ray apparatus.

- 2b. *Hollow cone rotation; moving patient:* The patient lies horizontally and is rotated about a vertical axis. The x-ray beam is incident at an angle with respect to this vertical axis. This has been employed with many types of units.

The latter two techniques produce isodose surfaces which are a series of concentric cones.

Other combinations of a moving patient or moving machine may be employed, but the above four categories represent the common patterns of rotation therapy.

In any category, either *complete* or *segmental rotation* may be employed. The latter is achieved by oscillating movement of the patient or of the radiation source.

The entire volume of intense dose distribution, or only part of it, (hemicylindrical irradiation) may lie within the body.

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SUMARIO

Principios de la Rototerapia de Supervoltaje (2 Millones de Voltios)

Las técnicas rotativas con rayos X de supervoltaje constituyen un importante adelanto en la radioterapia, pues permiten

la irradiación homogénea de un tumor con una dosis alta, en tanto que permanece baja la dosis por volumen llevada a los

tejidos normales. A consecuencia de ello, es posible conducir, con inocuidad, dosis tumor letales a ciertas neoplasias profundas que no podrían ser irradiadas eficazmente con las técnicas empleadas más habitualmente.

En la escala de supervoltaje de 2 a 22 Mv. la distribución de la dosis en el tumor y en los tejidos normales adyacentes es independiente del voltaje cuando se emplean campos pequeños. Tratándose de campos grandes, el voltaje más alto reduce ligeramente la dosis por volumen a los tejidos normales, en tanto que permanecen idénticas las dosis aplicadas al tumor.

El "sistema de coordenada del ángulo recto" para colocar el tumor en el centro de rotación constituye un método exacto y de repetición fácil para la irradiación de precisión. Requiere un contornímetro horizontal, una plataforma giratoria con dos travesaños perpendiculares y un puntero especial. Siempre que es factible, se utiliza la corroboración radiográfica con el haz de terapéutica.

Se han empleado con éxito variaciones de los principios fundamentales de la rotación del supervoltaje para el tratamiento de lesiones subsuperficiales, en particular tumores de la cabeza y del cuello.

DISCUSSION

J. W. J. Carpender, M.D. (Chicago, Ill.): It is always a compliment to be asked to discuss such an excellent paper as Dr. Friedman and his colleagues have presented.

The details of radiation in the particular case mentioned are so complete that discussion is not necessary.

An important point emphasized by Dr. Friedman is the serious danger of using directly opposing portals with supervoltage machines. The risk to normal tissues is clear. The lack of advantage except in certain special cases is obvious. The economical advantage of a high roentgen output in this type of therapy is also stressed. The initial cost of installation is so high that, except under unusual circumstances, many patients must be treated each day in order to justify the expenditure.

You have seen illustrations of several different types of rotation therapy using eccentric and segmental rotation. Careful selection of the proper method is important and, as shown by Quimby, the addition of single opposing portals can give even better dose distribution.

The importance of simple but accurate daily alignment, emphasized by Dr. Friedman, cannot be minimized, but I am a little worried. It seems to me it would be quite easy with this method to rotate the patient slightly about his vertical axis in the case of an eccentric tumor and get the tumor out of position while still conforming exactly to the other requirements of the method.

Classification or accurate nomenclature of methods of rotational therapy is important so that we may express ourselves with brevity without danger of being misunderstood. The terms used in this paper are simple but clear and descriptive.

When I read the presentation I was impressed by the simplicity of the methods used. My lack of experience may be leading me into the belief that there is perhaps over-simplification. Dr. Friedman makes

it much too easy. I had hoped that he would discuss the more complex methods of rotational therapy. The Boston group has used various devices to treat tumors of very irregular shapes. More recently there has been advocated a device using radiocobalt which allows masses of almost any conceivable shape to be treated. I wonder if Dr. Friedman feels that we can define the limits of internal tumors with such accuracy. My personal opinion is that we cannot even come close to such tumor definition.

Milton Friedman, M.D.: There is always a risk of the tumor moving out of position as the patient is rotated. Improvements in the rotating platform tend to minimize this. At this meeting is displayed a platform with some improvements that we have added to Dr. Trump's basic design, which serve to fix the patient in position.

This problem of movement of the patient is minimal, except in the case of very weak patients who should preferably be treated in the horizontal position. In most instances the patient remains fixed in position.

As to over-simplification of the technic, I doubt that it has been over-simplified. The first alignment of the patient is an extremely complicated and time-consuming procedure. For carcinoma of the bladder, for example, we place a Foley bag in the bladder and lead markers on four points of the skin and position the patient on the rotating platform. Films are taken either in the anteroposterior or lateral position. A double exposure is first made, with the size of the portal to be treated and then the whole region of the body, as Trump and Hare have illustrated. These are then checked against the cross-section diagram. Usually three or four films are taken before the final reference point on the skin is noted and the treatment started. The original planning of the treatment is thus rather complex, but the subsequent reproduction of daily treat-

ment is simple, about three minutes being required for the average set-up.

On the whole, we can treat 30 to 35 patients a day. To our surprise, it is probable that the high cost of this apparatus can be amortized over a period of about five years. This is important for those who are considering supervoltage rotation. I wish to emphasize that the choice of apparatus must depend to a large extent on a reasonably high roentgen flux, because an elaborate set-up which can treat only 5 to 10 patients a day may be economically unsound.

The cobalt bomb, when finally perfected in the sense of acquiring a large enough radioactive source, will be economically efficient, but even so, the distance from the cobalt source to the axis of rotation has to be reduced and certain eccentric and other forms of rotation around the head and neck may have to be sacrificed.

As far as the technic of irradiation of irregular masses is concerned, I am somewhat skeptical about its applicability to the actual clinical practice of irradiating tumors. One does not irradiate the tumor; we irradiate a tumor region and most of these happen to fall within rather simple geometric forms, either a cylinder or a sphere or a spheroid. I doubt that there will be too much indication for irregular patterns of rotation.

Carl B. Braestrup (New York, N. Y.): Dr. Friedman stated that with cobalt-60 we have to

use rather short source-skin distances. Actually, the main reason for using long distances is to cut down the skin dose. I believe, therefore, that little is gained by using source-skin distances of more than 50 or 60 cm. with high-energy radiation since the skin dose is already relatively low.

Frank H. Hoecker, Ph.D. (Lawrence, Kans.): At the risk of exciting a rebuttal by Mr. Braestrup, I'd like to say a word in support of Dr. Friedman's comments.

Dr. Friedman points out, and I think correctly, that in the case of cobalt sources, especially small cobalt sources, the short distance between the source and the tumor necessitates a short distance between the source and the diaphragm. If I remember correctly, the geometry of this situation considerably enlarges the penumbra effect and it seems to me that this would inevitably add to the unavoidable integral dose to the tissue.

I believe also that it would be considered heresy in a physicist to deprecate the use of gadgetry. In that regard I can only comment, or perhaps I might be allowed to venture a prophetic note, that considering the use of wedges—rotating wedges, cones, various forms and patterns of rotation—and the necessity of determination of the size and shape of the irradiated volume, I see a great future for radiological physicists in connection with moving field teletherapy.



Physical Aspects of Rotating Telecobalt Equipment¹

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UNTIL RECENTLY, cobalt teletherapy equipment has been of the stationary type, designed primarily to duplicate super-voltage x-ray machines. A rotating unit was installed in the Francis Delafield Hospital in May 1953. The construction of this unit has already been described (1). The beam orientation system differs fundamentally from that of conventional apparatus in that the source of radiation is able to move on the surface of a hypothetical sphere, with the useful beam always directed at the center. The basic factors of the equipment are as follows:

Diameter of cobalt source	2.5 cm.
Source-diaphragm distance	30 and 40 cm.
Radius of rotation	75 cm.
Maximum field diameter at axis	23 cm.
Dose rate, in air, at 75 cm.	33 r/min.
Dose rate, in air, at 100 cm.	19 r/min.

(June 1953)

The present paper reports the results of a study of dose distribution and protection requirements of the rotating unit.

EXPERIMENTAL SET-UP

Figure 1 shows the arrangement for determining the dose distribution. Masonite contour phantoms were used with both radiographic films and ionization chambers. Condenser chambers of 0.8 cm diameter were employed to measure the total dose during rotation, scanning, or oscillation, both at the axis and at other points of interest. The instantaneous dose rate was determined with a guard-ring thimble chamber connected to a Beckman micro-microameter. These same instruments served also for water phantom measurements with stationary fields. The tank, 30 × 30 × 30 cm., was made of Lucite

TABLE I: COMPARISON OF COBALT 60 CENTER-LINE DEPTH DOSES (8 × 8 cm. field; SSD, 60 cm.)

Depth, cm.	Dixon, Garrett, Morrison	Johns <i>et al.</i>	Richardson, Brucer*	Braestrup, Mooney
0.5	100	100	100	100
5	74.4	74.7	75.1	74.9
10	50.1	50.5	51.1	50.2
15	32.3	33.8	34.9	33.6
20	22.0	22.7	24.1	22.6

* Interpolated.

and could be used with either a vertical or a horizontal beam. Near the surface a flat guard-ring chamber with 1.5 mm. air spacing supplemented the thimble chamber measurements. The chambers were moved electrically from the control.

STATIONARY FIELDS

Table I shows a comparison of our water phantom measurements with the earlier work of Dixon (2), Johns (3), and Richardson (4). The agreement is considerably better than that usually obtained with high-energy x-rays. This may be ascribed to the constant dose rate and the nearly monoenergetic gamma radiation. Nevertheless, outside of the central beam considerable dose variation may be expected, depending upon the type of collimating system used. Figure 2 shows typical isodose curves obtained with a short source-diaphragm distance, 27 cm., giving a relatively large penumbra. From the point of view of penumbra, a longer source-diaphragm distance is desirable. Other considerations, however, enter into the selection of this dimension. As shown by Johns (3), the diaphragm preferably should be 20 cm., or more, from the skin of the patient in order to minimize electron contamination. With a rotating source, adequate clearance to the patient is another requirement, to prevent collision. For

¹ From the Physics Laboratory, Francis Delafield Hospital, New York, N. Y. Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13-18, 1953.

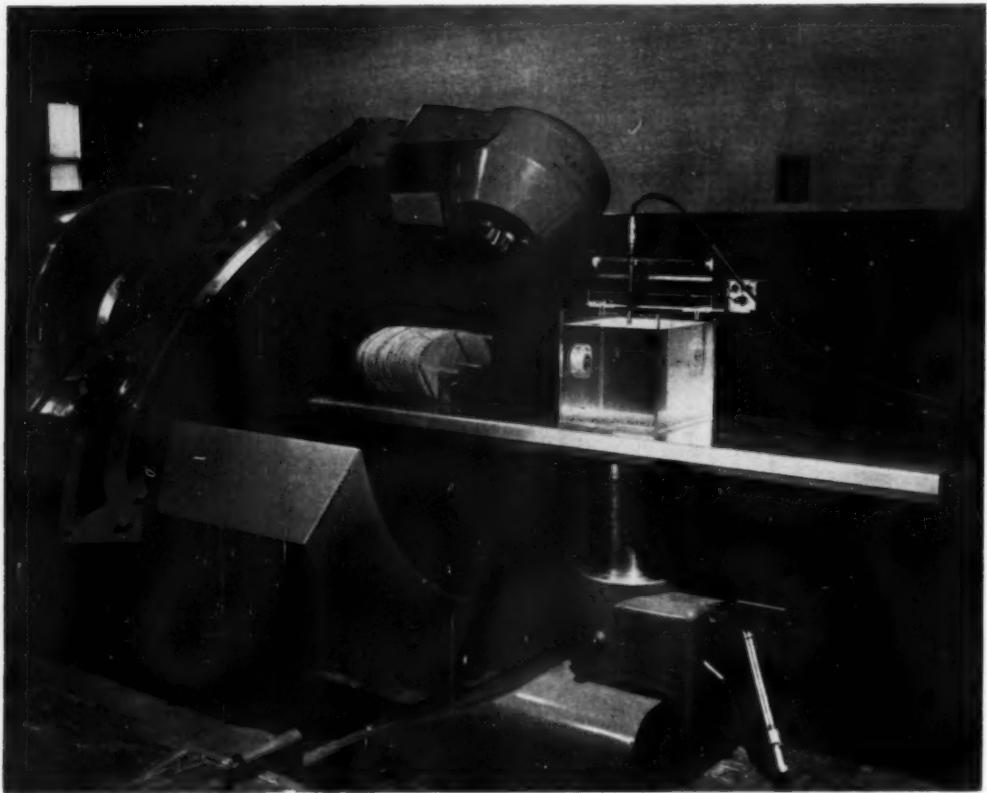


Fig. 1. Experimental arrangement for the determination of the dose distribution in water and Masonite phantoms.

TABLE II: DEPTH DOSE TABLE
(SSD 60 cm.)

Area in sq. cm.	50	100	200	300
"Air" dose	97.0	96.0	95.5	95.0
0.5	100	100	100	100
5	74.5	75.0	76.2	77.0
10	49.5	51.9	54.2	55.2
15	33.0	34.9	37.4	38.8
20	21.8	23.8	26.1	26.7
25	14.5	16.0	17.7	18.3
30	9.8	11.2	12.5	12.8

Note: The area refers to the nominal field size at skin, assuming a point source. Source-diaphragm distance 30 cm.

these reasons, the following source-diaphragm distances were selected: (a) 30 cm. for unrestricted rotation or oscillation, giving a geometrical penumbra of 3.8 cm. at the center; (b) 40 cm. for stationary fields and rotation in a vertical plane only or for scanning and oscillation, giving a geometrical penumbra of 2.2 cm. at the center.

Table II shows the center-line depth doses for various field sizes. It will be noted that the change in depth dose with field size is small, as might be expected, since the scattering is mainly in the forward direction. The depth dose is about 10 per cent higher than that obtained on our 2-Mv x-ray equipment, h.v.l. 0.7 cm. Pb, after correcting for the difference in distance. This table is given in the conventional form, for comparative purposes (Table III). With a moving source of radiation, however, it has been found more practical to express the tissue dose in terms of the dose at the center of rotation rather than in percentage of surface dose. This greatly simplifies dosage calculations and puts emphasis on the amount of radiation delivered to the tumor rather than the "air" or skin dose. It has already been

TABLE III: DEPTH DOSE FOR 2,000 KV.P. (h.v.l. 0.7 CM. Pb; T.S.D., 100 CM.)

Area → Sq. cm. →	3 × 3	5 × 5	5 × 10	8 × 10	10 × 10	10 × 15	15 × 15	15 × 20	20 × 20
	9	25	50	80	100	150	225	300	400
"Air" dose	100	100	99	98	96	96	96	96	96
0.4 cm.	100	100	100	100	100	100	100	100	100
1.0	98	98	98	98	98	98	98	98	98
2.0	92	93	93	93	93	94	95	95	96
3.0	85	86	87	88	88	89	91	92	92
4.0	79	80	82	83	83	84	86	88	88
5.0	73	74	76	78	79	80	81	83	83
6.0	66	68	71	72	73	75	76	78	79
7.0	61	64	66	67	68	70	72	74	74
8.0	56	58	61	63	64	66	67	69	70
9.0	52	54	57	58	59	61	63	65	65
10.0	46	48	52	54	55	58	60	61	61
11.0	43	45	48	50	51	53	55	57	58
12.0	39	41	43	45	46	49	52	54	54
13.0	36	37	40	42	43	46	48	49	50
14.0	33	35	37	39	40	43	45	46	47
15.0	30	31	34	35	36	39	42	43	43
20.0	18	19	22	24	24	26	29	29	30
25.0	12	12	14	15	16	17	20	20	21

established clinically that in the treatment of deep-seated tumors the tolerance of the skin is not as limiting a factor with supervoltage radiation as with conventional 250-kv x-rays.

MOVING FIELD

Center Dose: Since the source-center distance is fixed, the dose at the center depends solely on the attenuation of the rays, and for a given field size, therefore, on the radial thickness of tissue through which the beam has to pass. This is illustrated in Figure 3, which shows the relation between the dose rate at the center of the Masonite contour phantom and the angle of the beam. The curve was obtained by means of a recorder connected to a micro-microameter which measured the ionization current of a thimble chamber placed at the center of rotation.

This curve was used also to establish the relation between the center dose rate and the radial thickness of tissue. This is shown in Figure 4. On this graph is indicated, too, the results obtained using a 30 × 30 cm. phantom. It will be seen that the center dose rate is essentially the same whether the phantom surface is curved, or flat and at right angle to the beam. The reason for this is obvious from Figure 5.

To eliminate the need of measuring the

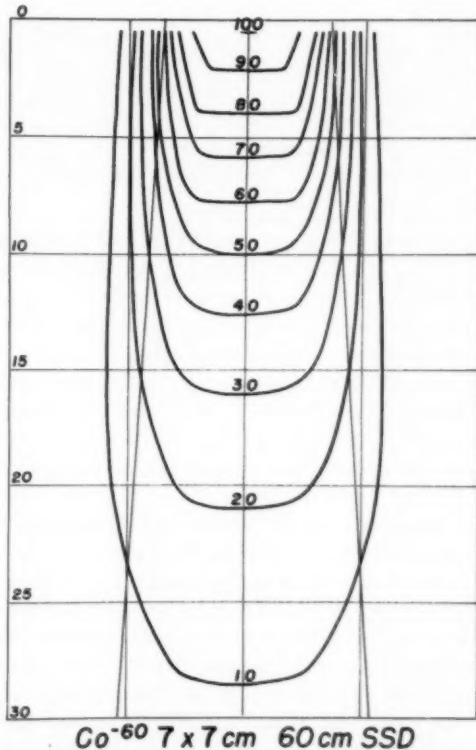


Fig. 2. Typical isodose pattern obtained with a source-diaphragm distance of 27 cm.

center surface distance and then, by means of tables, determining the center dose rate, scales were made which give directly the

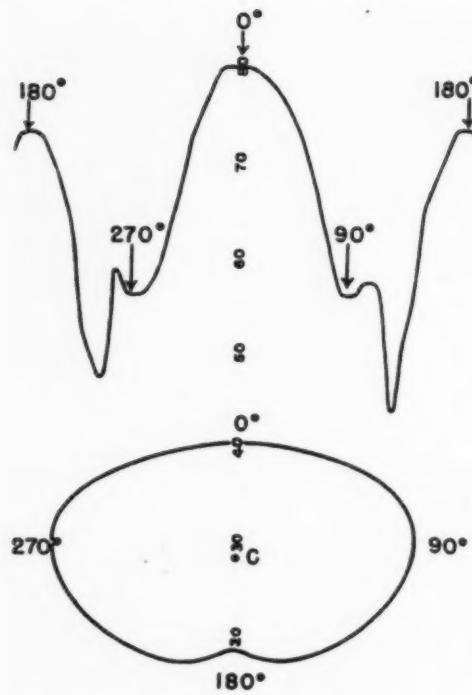


Fig. 3. Relation between the dose rate at the center of the Masonite contour phantom and the angle of the beam. The reduction in dose rate at 125° and 235° is the result of the additional attenuation by the structural supports of the treatment couch.

center dose for different tissue thicknesses. This relation is shown in Table IV for different field sizes. The use of these scales is illustrated in Figure 6, which shows a board provided with radial lines for every 30° and a peg at its center. The contour of the patient is drawn on transparent paper, which is punctured at the proposed center of rotation by the peg. With the scale placed on the peg, it is possible to read off directly the contribution of each radial beam to the center dose; the average value is then computed in conventional manner. The attenuation by the treatment couch is compensated for by including the path through its tissue equivalent cross section, which is drawn below the contour of the patient. It was found that the actual reduction in the center dose due to absorption by the couch is only 5 per cent for the above condition,

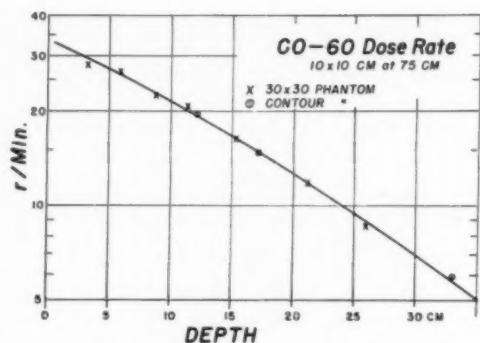


Fig. 4. Relation between the center dose rate and phantom thickness for a flat and a contour phantom.

with complete rotation. Any small error in this compensation is therefore insignificant. Excellent agreement has been found between the center dose calculated in this way and the measured dose at the

TABLE IV: RELATION BETWEEN CENTER DOSE AND TISSUE THICKNESS

Center Dose in per cent of Center "Air" Dose	Tissue Thickness*, cm.		
	6 X 15 cm. (8.8 X 8.8)	10 X 10 cm.	15 X 15 cm.
84		4.4	6.4
82		4.8	6.8
80	5.0	5.3	7.3
78	5.5	5.9	7.8
76	6.0	6.5	8.4
74	6.5	7.0	8.8
72	7.0	7.5	9.4
70	7.5	8.1	10.0
68	8.1	8.9	10.6
66	8.7	9.5	11.2
64	9.2	10.1	11.8
62	9.8	10.7	12.4
60	10.4	11.3	13.1
58	11.0	12.0	13.8
56	11.7	12.6	14.4
54	12.3	13.3	15.2
52	13.0	14.0	15.9
50	13.7	14.7	16.7
48	14.5	15.5	17.5
46	15.3	16.3	18.3
44	16.0	17.1	19.2
42	16.8	18.0	20.2
40	17.7	18.9	21.1
38	18.7	19.8	22.2
36	19.7	20.8	23.3
34	20.7	21.9	24.4
32	21.8	23.0	25.6
30	23.0	24.2	26.9
28	24.3	25.5	28.3
26	25.6	26.9	29.7
24	27.0	28.4	31.3
22	28.6	30.0	33.1
20	30.3	31.7	35.0

* Radial distance from center to surface.

center, in this case 17.0 r/min. against 17.6 r/min.

This method of center dose calculation can be used also when the beam is oblique to the axis of the patient, provided the cross section of the patient is in the plane of rotation. The same system may be applied in scanning over a limited arc. The maximum dose, however, may no longer be at the center of rotation.

Off-Center Dose: So far, only the dose at the center has been considered. In most clinical problems it is necessary to know, also, the dose at other points. These determinations may be made most

TABLE V: DOSE DETERMINATION FOR COBALT 60

Degrees	Center %		Point A %		Point B %	
	Center "Air" Dose	Center Dose	Center "Air" Dose	Center Dose	Center "Air" Dose	Center Dose
0	68.0	85	57.8	190	129.0	
30	65.3	88	57.5	110	71.9	
60	54.0	94	50.7	20	10.8	
90	41.4	102	42.2	12	5.0	
120	45.0	108	48.7	20	9.0	
150	50.4	114	57.4	50	25.2	
180	59.4	115	68.3	57	33.9	
210	50.4	112	56.4	48	24.2	
240	45.6	105	47.9	18	8.2	
270	42.7	98	41.8	12	5.1	
300	56.7	92	52.1	22	12.5	
330	66.0	88	58.1	115	75.9	
Total	644.9		638.9		410.7	
Average	53.7		53.2		34.2	
r/min. (cal.)	17.0*		16.9		10.9	
r/min. (meas.)	17.5				10.4	

* Corrected for 5 per cent attenuation in couch.

conveniently if the isodose curves are plotted in percentage of the center dose. These were obtained with a source-skin distance of 60 cm. However, measurements made at other source-skin distances indicate that within the usual range this factor changes the isodose curves insignificantly, provided they are expressed in percentage of the center dose. This is consistent with the previous results, shown in Figure 4, which indicate that the relation between dose rate and tissue thickness is very nearly exponential. For this reason, the ratio between the doses at points O and A, shown in Figure 7, remains

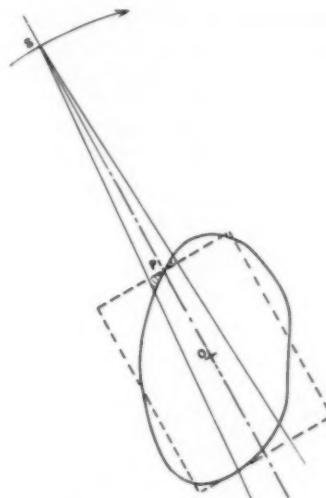


Fig. 5. Schematic diagram to illustrate the effect of phantom surface on the center dose rate for a given phantom thickness. The increased thickness above and to the right of point P tends to compensate for the reduced thickness below and to the left of point P. Because of this compensation, the dose rate at O, for a given radial thickness, is essentially the same for both the contour phantom and the flat phantom (indicated by the broken lines).

nearly constant with variations in source-skin distance.

The use of the isodose curves is illustrated in Figure 8. They are used in a manner similar to that in determining the center dose. That is, readings are taken every 30° for the points of interest. This may be done simultaneously with the center dose determinations, as shown in Figure 6.

The results thus obtained are shown in Table V. The figures of the bottom line are the measured values obtained with condenser ionization chambers placed at the points of interest. The agreement appears to be satisfactory for most clinical problems, particularly for points not too close to the skin. For points near the skin the calculated values are high, since no correction has been made for the decrease in scattering from above and possible lack of electronic equilibrium.

By means of the above method, complete isodose patterns have been established for the more common technics. A typical

dose distribution in the treatment of cancer of the cervix is shown by Figure 9. As indicated, this is for a given size of patient cross section. The same isodose pattern may be used, however, for other sizes provided there is a fixed increment in the radial thickness in all directions.

RADIATION PROTECTION

The leakage radiation of the source housing with the beam shutter closed should obviously be as small as possible to minimize the exposure of the staff during set-up of patients. This radiation was measured with condenser ionization cham-

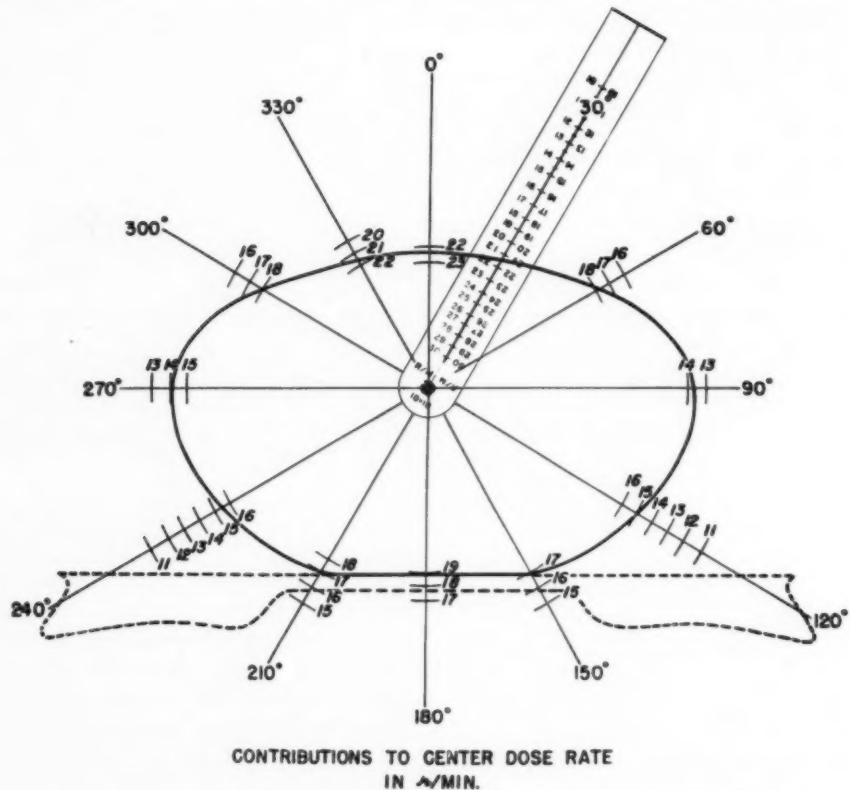


Fig. 6. Method of determining the radial beam's contribution to the center dose for each 30° interval. The dotted lines indicate the treatment couch's tissue equivalent cross section.

Patterns obtained with different size cross sections reveal that the dimensions of the patient have only a minor effect on the relative dose distribution for the same part of the body. Field size, location of center of rotation, and degree of scanning, on the other hand, all produce a significant effect. A set of isodose patterns has been prepared, therefore, for the common types of lesions, treated by what appear at present to be the most effective techniques.

bers placed at 1 meter from the source in various directions. The results, shown in Figure 10, are plotted on polar co-ordinates in mr/hr. It will be seen that the leakage radiation varied greatly, from 0.3 to 16 mr/hr. The high values were found to be due to small air spaces in the shielding caused by incomplete lead filling; the cracks were located by means of radiographic films placed in contact with the housing.

Although film badges and dosimeters

worn by the staff showed less than 50 mr per month, the source housing was replaced to comply with the new National Committee on Radiation Protection Subcommittee recommendations (8). According to this code "the housing and collimating devices shall be so constructed that at one meter in any direction from the source in the 'off' position the maximum and average dose rate do not exceed 10 mr/hr. and 2 mr/hr. respectively." As shown in Table VI, the present source housing meets these requirements.

TABLE VI: LEAKAGE RADIATION

Degree	Old Source Housing (mr/hr. at 1 meter)	New Source Housing
0	5.2	2.9
30	3.6	1.6
60	6.6	1.3
90	4.2	0.8
120	0.8	0.3
150	0.3	0.5
180	0.5	0.8
210	0.4	0.8
303	15.8	3.1
315	5.5	2.1
330	3.1	1.4
Average	4.2	1.4

With the type of equipment used in this investigation, the useful beam is attenuated by the counterweight-shield; the floor, walls, and ceiling of the room are therefore exposed essentially to scattered rays only. The dose rate and quality of the scattered radiations thus determine the shielding requirements of the room, and these are of interest in the planning of future installations. Figure 11 shows the arrangement used for determining the dose rate and quality of the scattered radiation. A cylindrical Masonite phantom, 30 cm. in diameter, was used in place of the patient in order to have just one variable, the angle of scattering. A condenser chamber was mounted on a turntable at a distance of 1 meter from the center of the phantom and could be enclosed in cylindrical lead shields for determination of the half-value layer.

The results are shown on polar co-ordinates in Figure 12. The scattered radiation

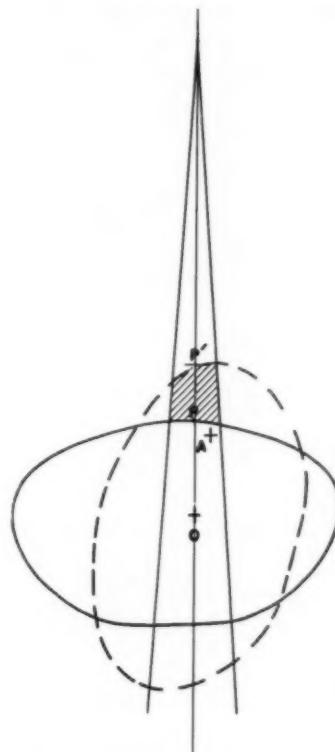


Fig. 7. Schematic diagram to illustrate the effect a varying source-skin distance has on the relative depth dose at an off-center point.

is expressed in per cent of the air dose at the center of the phantom. The lower portion shows the percentage and the upper portion the half-value layer. The solid lines are for maximum field size, 23 cm. diameter; the dotted for a 10 x 10-cm. field. As might be expected, the percentage is highest, about 0.4 per cent, for the smallest angle of scatter, 38 degrees; at 90° it is less than 0.1 per cent. For the smaller field, the percentage is very much reduced, but the half-value layer is increased.

Measurements made without the phantom in place indicate that for small angles the collimating diaphragm contributes about half of the scattered radiation. The half-value layer of the radiation scattered from the diaphragm was found to be nearly equal to that of the primary beam, that is 10 mm. Pb. This might be expected,

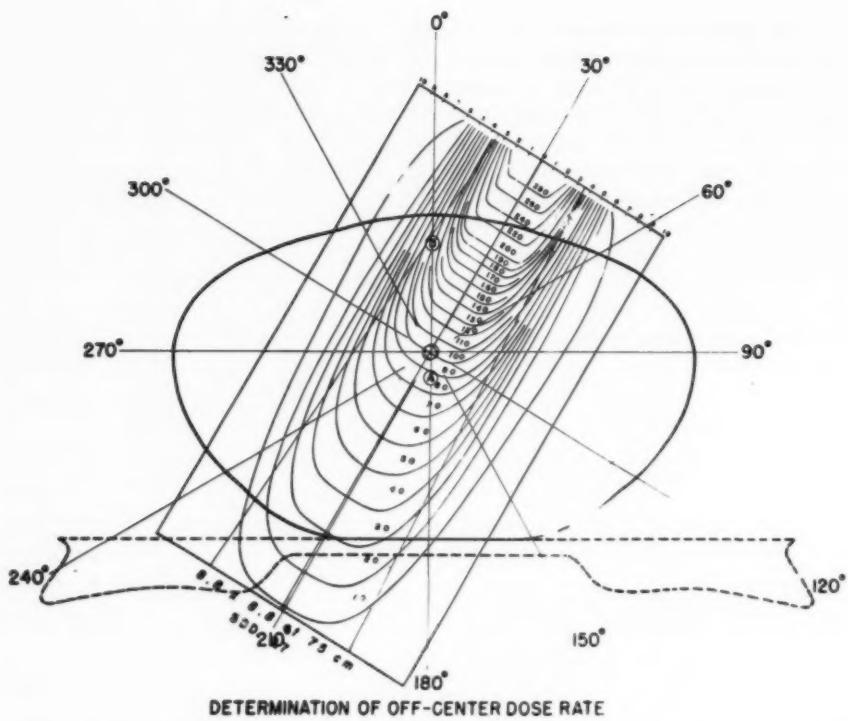


Fig. 8. Method of determining, for given intervals, the radial beam's contribution to the dose at points off center.

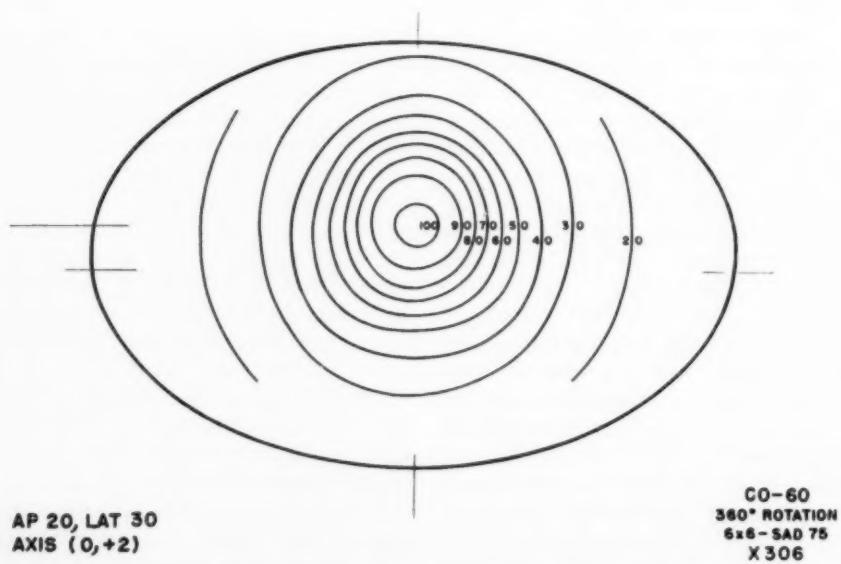


Fig. 9. Typical isodose pattern used in the treatment of cancer of the cervix. Ratio of axis dose to air dose, 0.57.

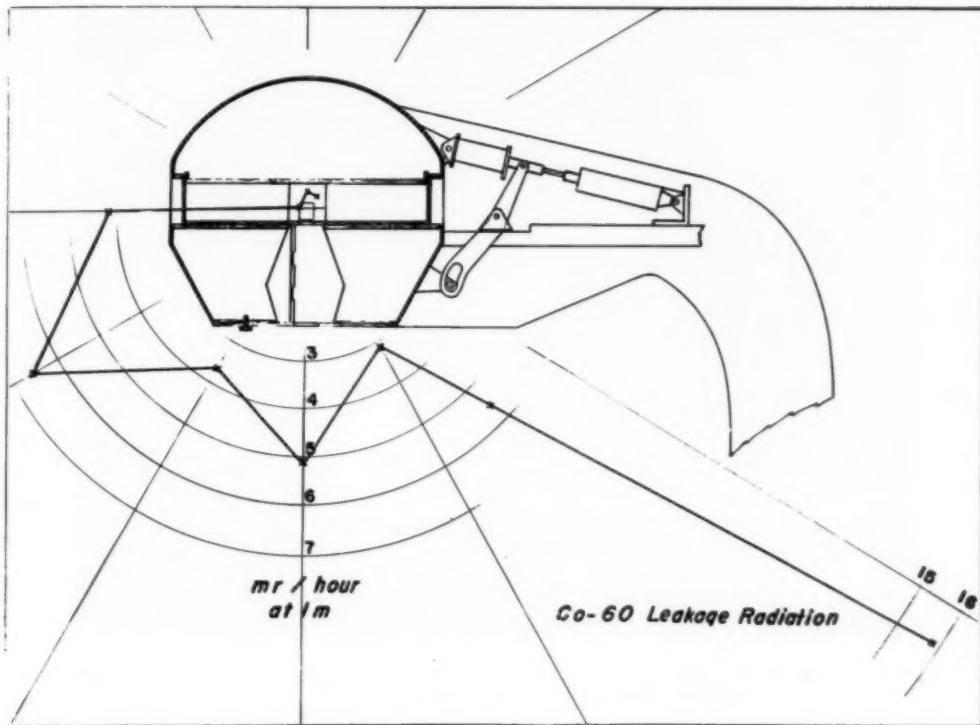


Fig. 10. Polar coordinate plot of the leakage radiation from the original source housing. Measurements were made at 1 meter from the source for the indicated angles. The leakage radiation from the present source housing is given in Table VI.

due to the small angle of scatter and less multiple scattering. By modifying the diaphragm design, it is possible to reduce materially its contribution of scattered radiation.

DISCUSSION

The results of this study indicate that very high tumor-skin dose ratios are obtainable with cobalt 60 rotation therapy. Obviously, the dose distribution is the same whether the patient or the source moves; however, rotating the source around the recumbent patient has the advantage of better fixation and less discomfort to the patient. Rotation therapy in the past has required time-consuming dose calculations. The dosage system described here greatly simplifies tissue dose determinations for moving field therapy and provides an accuracy entirely ade-

quate for clinical purposes, especially for cobalt 60 or supervoltage roentgen radiation. Preliminary measurements at 250 kv. indicate that the same dosage system may be applied also to conventional x-ray rotation therapy; however, more complete isodose patterns are required for that purpose. These are now in course of preparation and will be presented in a separate report.

The relation between the leakage radiation of the source housing and the weekly dose received by the teletherapy technicians indicates that the requirements of the new cobalt 60 Protection Handbook (8) provide a very high factor of safety. Even with the temporary tube housing, the technicians received less than 50 mr per month, although the leakage radiation was in excess of present recommended limits.

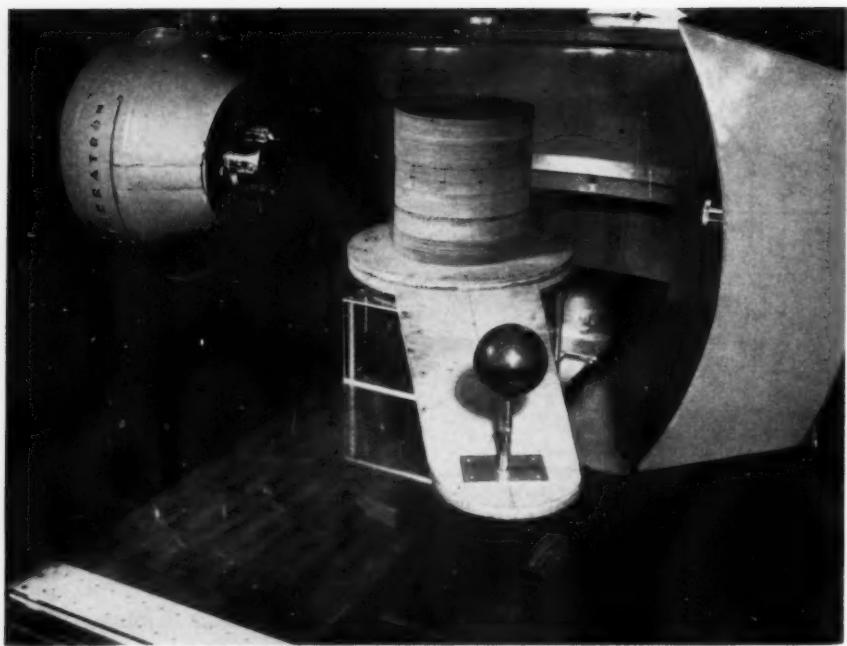


Fig. 11. Experimental arrangement for the determination of the dose rate and quality of the radiation scattered from a cylindrical Masonite phantom.

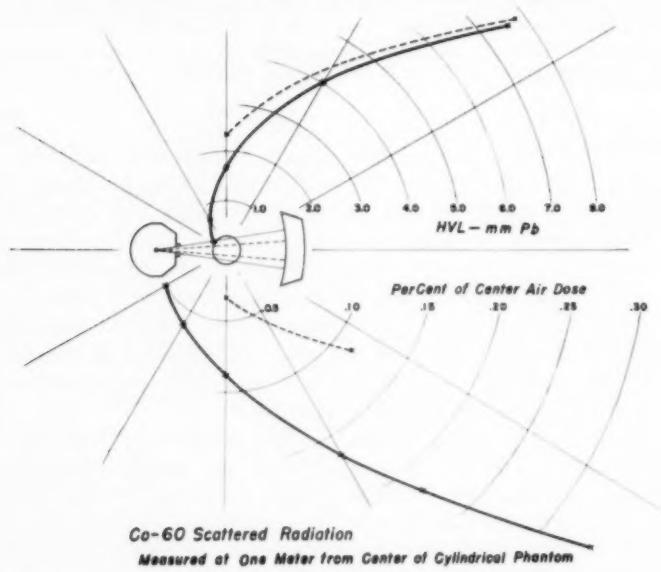


Fig. 12. Polar co-ordinate plot of the relative dose rate and quality of the scattered radiation. The upper portion shows the variation of quality with scattering angle. The lower portion shows the variation of the relative dose rate, expressed in per cent of the center air dose, with scattering angle. Measurements were made at one meter from the center of the cylindrical Masonite phantom. The solid lines are for a 23-cm. diameter field, the dotted for a 10 \times 10-cm. field at the center.

In conclusion it may be of interest to compare cobalt 60 teletherapy with supervoltage irradiation. The initial cost of the teletherapy apparatus is somewhat lower than present supervoltage x-ray equipment. Other advantages of cobalt 60 teletherapy are: no need of heavy electric wiring, fewer replacement parts, less likelihood of discontinuity of service due to breakdown of equipment, and no fluctuation in dose rate. On the other hand, supervoltage x-ray equipment has the advantage that the source of radiation can be turned off, and the dose rate is much greater than that available with present cobalt sources. Furthermore, the focal spot of the x-ray tube is small, resulting in insignificant penumbra. However, most of the present limitations of cobalt teletherapy will be eliminated with the availability of low-cost, high-specific-activity cobalt 60.

NOTE: The authors acknowledge with thanks the valuable technical assistance rendered by Mr. William Weisman and Miss Elsie Testa of this laboratory.

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SUMARIO

Aspectos Físicos de la Instalación Rotatoria de Telecobalto

Preséntanse los resultados de un estudio de los requisitos de distribución de dosis y protección de un aparato de cobalto-60 para teleterapia rotatoria instalado en el Hospital Francis Delafield, de Nueva York, en mayo de 1953. Los resultados indican que con ese aparato se obtienen proporciones muy altas de dosis tumor-piel.

Para campos estacionarios, la dosis profunda en la línea central no varía más que ligeramente con el tamaño del campo, dado que la dispersión tiene lugar principalmente hacia adelante. La dosis profunda resultó ser aproximadamente 10 por ciento más alta que la obtenida con la instalación de rayos X de 2 Mv. (c.h.r. 0.7 cm. Pb).

Para campos móviles, la dosis central depende exclusivamente de la atenuación de los rayos, y por lo tanto, para un campo

de tamaño dado, del espesor radial que debe atravesar el haz. Las dosis fuera del centro se basan en el tamaño del campo, la localización del centro de rotación y la meticulosidad del escrutinio.

Describese un sistema de dosificación que simplifica considerablemente las determinaciones de la dosis tejido para la terapéutica en campos móviles y que aporta una exactitud absolutamente adecuada para fines clínicos.

La relación entre la radiación escapada del mueble que aloja el foco y la dosis semanal recibida por los técnicos indica que los requisitos de la Oficina Nacional de Normas de los E.U.A., expuestos en el *Handbook 54, Protection against Radiation from Radium, Cobalt-60 and Cesium-137*, ofrecen un alto factor de seguridad.

(*For discussion, see following page*)

DISCUSSION

Frank H. Hoecker, Ph.D. (Lawrence, Kans.): It is important to recognize the valuable contribution by Mr. Braestrup to the advancement of radiation therapy. The development of the unique rotational therapy unit which was described in a recent issue of *RADIOLOGY* (61: 614, October 1953) provides a much needed opportunity to obtain physical and clinical data upon which an evaluation of the place of high-energy rotation therapy can be based. The data which have been presented here constitute a first step in that direction.

There are in this paper a number of significant statements which seem to me to have important implications when viewed in relation to their effect on treatment planning.

The figure showing the isodose curves expressed in terms of per cent of center dose is a real contribution to the determination of the dose to intervening tissue. In the light of the figure showing the marked dependence of dose rate on the thickness of intervening tissue, one can commence to comprehend the complexity of tumor dose calculation for a rotating or oscillating beam. In such a case the center dose is continually changing because of the continuous variation in the thickness of the intervening tissue, and it would appear that an adequate evaluation of tumor dose could be obtained only by mathematical or physical integration of the varying dose rate for each rotational or oscillational pattern.

It seems important, also, to consider the further implications of this figure in relation to the size and shape of the tissue volume which receives a predetermined tumor dose. It should be kept in mind that in general the point receiving a maximum dose in rotational or oscillational patterns will not coincide with the center of rotation. This is true, of course, because even in the conventional cross-fire techniques it is due to the variation of depth dose with target-to-tumor distance and tissue thickness.

With two or three fixed ports of entrance, it is fairly simple to take account of this by the use of superimposed isodose curves. With complex rotational or oscillational patterns in which the angle of intersection of the beam with itself

varies continuously, the problem of determining the size and shape of the irradiated volume becomes exceedingly complex and laborious.

It seems to me that the future of rotational therapy is closely linked with the integral dose. It has already been stated by Mr. Braestrup that it has been established clinically with super-voltage x-rays that the tolerance of the skin is not the limiting factor in applying high-energy radiation to deep-seated tumors. This being true, it would seem that conventional cross-fire techniques which endow the radiologist with a choice of fixed entrance portals have advantages which radiologists may be reluctant to relinquish. These fixed entrance portals may be chosen in relation to a minimum of intervening tissue, thereby minimizing the integral dose, and may be selected so as to avoid especially sensitive vital tissue. In rotational and in oscillational patterns, the beam in some portions of its path must inevitably penetrate on the average greater thicknesses of tissue with a resulting greater integral dose.

In his excellent refresher course this morning, Dr. Titus Evans pointed out the greater damage of whole body radiation as compared with partial volume irradiation. Considering the difficulty of avoiding sensitive vital tissue in rotation therapy, it would seem that it is a step in the direction of greater tissue damage.

I hope you will bear in mind that these remarks are largely theoretical in nature. I hope that others, better qualified than I, will comment on the therapeutic aspect of the rotational technic.

Carl B. Braestrup (closing): I just want to answer Dr. Hoecker's question as to the use of rotation. Dr. Hoecker was concerned about the volume dose. I agree that there are many cases where there is no gain by using complete rotation and the integral dose may be increased unnecessarily; however, it may often still be advantageous to scan over a limited arc. Even with stationary fields, convergent beam orientation with the source of radiation moving on the surface of a sphere, and the beam directed at the center, offers definite practical advantages in setting up the patient.

Factors Influencing the Roentgen Visualization of the Gastric Mucosa

LAWRENCE A. DAVIS, M.D., PETER K. KNOEFEL, M.D., and EVERETT L. PIRKEY, M.D.

ATTEMPTED visualization of the gastric mucosa with barium sulfate has met with varying success. Whether this is due to differences in the preparation of the barium sulfate or in constitutional factors in the subject is not known. While it has been claimed (1, 2) that the use of barium sulfate of particle size smaller than that of U.S.P. BaSO₄ is advantageous, we found in a previous study (3) that results with such preparations were indistinguishable from those of BaSO₄ U.S.P. in the same person, though they varied widely from one individual to another.

The present study was undertaken in an attempt to determine (a) whether various patient factors, such as age, weight, sex, and the composition and volume of the resting gastric juice, had any effect upon the visualization of the rugal pattern of the stomach by the opaque medium, and (b) whether particle size of BaSO₄ greater than that required by the U.S.P. influenced the pattern.

METHODS AND MATERIALS

Patients appearing in the x-ray department of the hospital for routine gastrointestinal examinations were measured for height and weight. A gastric tube was passed and, under fluoroscopic control, the tip was placed in the most dependent portion of the stomach. Aspiration was then accomplished in the upright position, in the supine position, with the left side up, and finally with the right side up, as the tube was withdrawn to the region of the cardia. The volume obtained was recorded and 10 c.c. of the secretion were retained

for laboratory studies. The patient was then returned to the upright position and 1 oz. of the opaque medium was administered. The barium preparations were used in 1:2 weight/volume suspension. Two samples of BaSO₄ were used: all of the particles of BaSO₄ I were more than 1.5 micra in size, and the preparation failed to conform to the U.S.P. sedimentation test; two-thirds of the particles of BaSO₄ II were less than 1.5 micra. Determination of particle size was made in the Research Laboratories of the Eastman Kodak Company (4). Tetraiodophthalimidooctanol (T.I.P.E.) (5) was used in a 1:3 weight/volume suspension.²

Under fluoroscopic control, the medium was spread by the gloved hand throughout the stomach; the patient was placed in the prone position and a film was obtained. A second film was taken with the patient in the supine position. The regular gastrointestinal examination was then carried out.

The gastric secretion was analyzed for acidity with the glass electrode and by titration to phenolphthalein, and for mucin by determination as dextrose (6) after two hours hydrolysis in 2 N H₂SO₄ in a boiling water bath (7). One hundred and fifty-two observations were carried out on 102 subjects: 77 observations in male, 75 in female subjects. The mucosal pattern films were viewed by radiologists who were ignorant of the opaque medium used. The observations were graded 1 to 4, according to the following criteria:

Class 1. Poor: almost no pattern visible (Fig. 1A).

¹ From the Departments of Pharmacology and Radiology, University of Louisville School of Medicine, Louisville, Ky. Aided in part by a grant from the Research Laboratories, Eastman Kodak Company, Rochester, N. Y., and by a grant from the Kentucky State Research Commission. Illustrations from the Department of Visual Education, University of Louisville.

Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13-18, 1953.

² Tetraiodophthalimidooctanol furnished in experimental quantities by the Research Laboratories, Eastman Kodak Company, Rochester, N. Y.

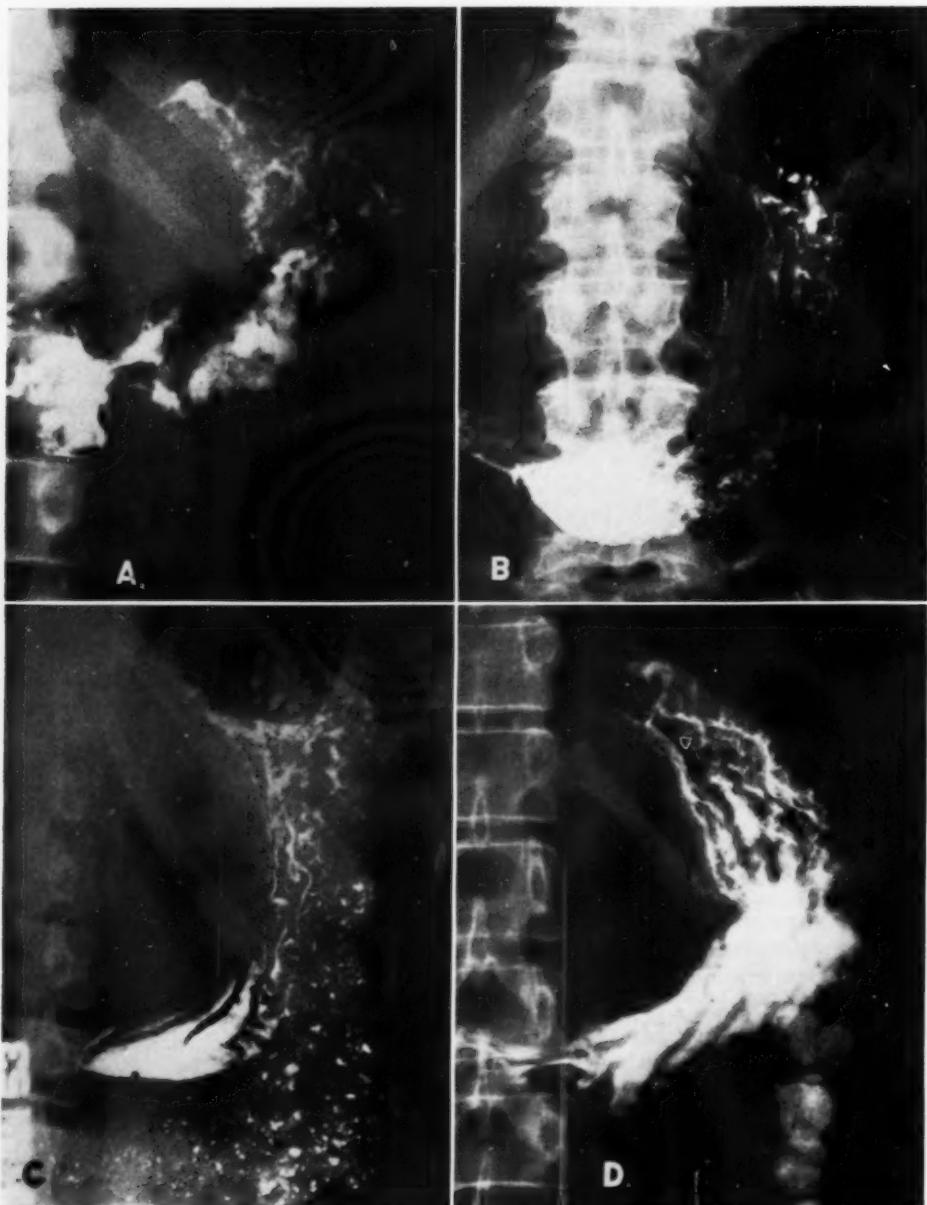


Fig. 1. Examples of rugal pattern classification. A. Class 1. Poor: Almost no pattern visible. B. Class 2. Fair: Pattern visualized in only a small portion of the stomach. C. Class 3. Good: Rugae well shown in most of stomach. D. Class 4. Excellent: Excellent visualization of rugae in entire stomach.

Class 2. Fair: Pattern visualized in only a small portion of the stomach (Fig. 1B).

Class 3. Good: Rugae well shown in

most of stomach (Fig. 1C).
Class 4. Excellent: Excellent visualization of rugae in entire stomach (Fig. 1D).

Each film was seen by at least two radiologists. If their grading did not agree, a third reading was made. The consistency of each examiner was checked by having him reread many films after an interval of time. It was found that a given examiner was remarkably consistent with his own readings and generally consistent with other examiners. In only 2 instances did 2 examiners differ by as many as 2 classes in their evaluation. The results were then statistically analyzed.

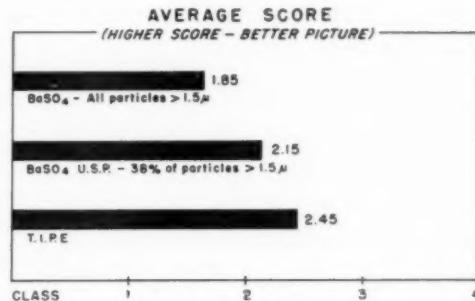


Fig. 2. Opaque medium and average score.

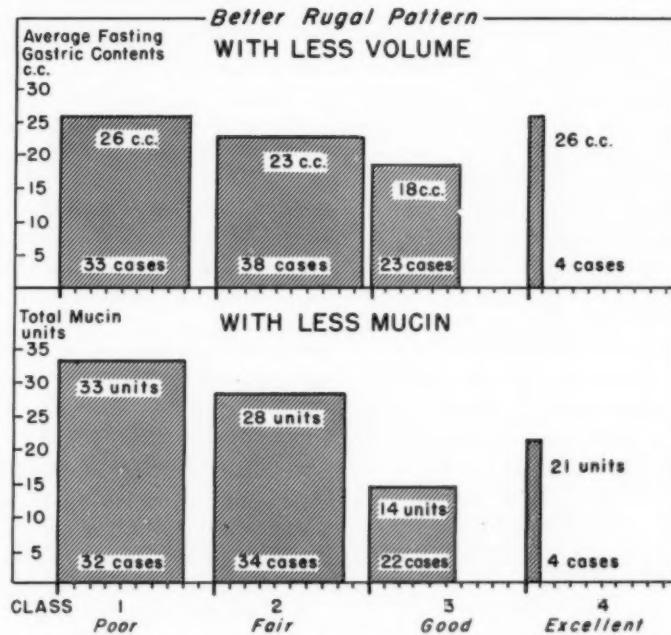


Fig. 3. Class of result, volume of resting gastric secretion, and mucin.

RESULTS

Previously we have shown that barium sulfate preparations with a particle size less than that of the U.S.P. BaSO_4 are of no greater value than the latter (3). A BaSO_4 suspension with particle sizes larger than in the U.S.P. preparation proved inferior. An analysis of the results is shown in Table I and Fig. 2. T.I.P.E. apparently was slightly superior to the BaSO_4 preparations in defining the gastric rugal pattern. These results appear to

be significant, as a χ^2 analysis (8) of the data represented in Table I gave a probability of 98.8 per cent.

There was no apparent correlation of age, weight, height, or gastric acidity, with the class of rugal pattern observed. On the other hand, there appeared to be an inverse correlation between the volume of the resting gastric secretion and the class of the pattern, the better pattern being demonstrated in those patients with the smaller volumes (see Fig. 3). There appeared, also, to be an inverse correlation

TABLE I: RESULTS OF OBSERVATIONS WITH THREE MEDIA

Substance	No. of Observations	Classification of Results (as percentage)			
		1	2	3	4
BaSO ₄ I	58	36	47	14	3
BaSO ₄ II	45	27	33	36	4
T.I.P.E.	49	12	43	33	12

between the total units of mucin in the gastric juice and the rugal pattern (Fig. 3). These results have less statistical probability of significance than is desirable. An analysis of variance (9) gave the following F values. For result of classification *vs.* volume: BaSO₄ I, F = 2.10; BaSO₄ II, F = 2.74. For result of classification *vs.* mucin: BaSO₄ I, F = 4.47; BaSO₄ II, F = 1.20. The F values at the 5 per cent level of significance were 8.58-8.60. Apparently the results with T.I.P.E., an organic iodide preparation, were uninfluenced by the mucin or volume content.

DISCUSSION

It would appear useful in an evaluation of an opaque material or special preparation to have a knowledge of the amount and make-up of the gastric juice of individual patients. In this connection it was also noted that many patients showed a considerable variation from day to day in the amount of mucin present in the stomach, while in some cases there was a variation in the volume of the resting gastric secretion. The use of a single patient for comparative analysis of several opaque media without individual aspirations on separate days may lead to false assumptions. From our experience we feel that evaluation of the medium must be performed objectively. The classifier must be totally unaware of the medium used, and a statistical test of the reliability of the results should be made.

As concerns particle size, no advantage accrues from the use of media of a particle size less than BaSO₄ U.S.P. (3), although larger particles give poorer results. It is of interest that our BaSO₄ I with large particle size, failing to conform to the U.S.P. sedimentation test and giving poorer

results, nevertheless bore the label "U.S.P."

The correlation between the mucosal pattern obtained and the volume of the resting gastric juice appears to substantiate commonly held concepts.

Flocculation of the opaque material by mucin in the stomach may parallel similar findings in the small intestine (10, 11). In addition, this strongly suggests the possibility that evaluation of various opaque media in the normal intestines may be hampered by the amount of mucin in the stomach. Flocculation may have already occurred in a barium suspension before it has reached the small intestine and evaluation of the latter pattern in such cases may be entirely unwarranted.

To improve demonstration of the average gastric rugal pattern, it would appear that the amount of resting gastric secretion should be reduced. Some suspending medium which would inactivate the gastric mucin might be used. T.I.P.E., because of its ability to produce a clearer pattern, and because its score apparently was not affected by the volume and mucin content, may be a useful agent.

SUMMARY

1. In roentgen visualization of the gastric mucosa with an opaque medium, the results are influenced by the volume of the resting gastric juice as well as the physical composition of the medium.

2. Barium sulfate preparations with a particle size greater than that of U.S.P. BaSO₄ are undesirable.

3. The greater the volume of resting gastric secretion, the poorer was the rugal pattern obtained. Similarly, the greater the total mucin content, the poorer was the rugal pattern obtained.

4. T.I.P.E., an organic compound containing iodine, gave better results than did barium sulfate.

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NOTE: We would like to express our appreciation to Miss Lila Hargan for the chemical determinations on the gastric secretions, and to Mr. Warren Dennis for the statistical analyses.

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SUMARIO

Factores que Afectan la Visualización Roentgenológica de la Mucosa Gástrica

Hiciéronse estudios del patrón de la mucosa gástrica según lo revelaran tres distintos medios opacos: dos preparaciones de sulfato de bario y un compuesto de yodo (tetrayodoftalimidoetanol).

El sulfato de bario de partículas mayores que las de BaSO₄, F.E.U., resultó desventajoso para la observación del patrón de la mucosa. El tetrayodoftalimidoetanol dió resultados ligeramente mejores que el bario. No hubo aparentemente relación entre la

edad, el peso, la talla, o la acidez gástrica del enfermo con la clase de patrón de las arrugas obtenido. Mientras mayor era la secreción gástrica en descanso y mayor el contenido total de mucina en ella, peor fué la observación del patrón de las arrugas.

Este estudio complementa uno anterior en el que se demostró que el sulfato de bario de partículas más pequeñas no ofrecía la menor ventaja sobre el BaSO₄, F.E.U. (*Radiology* **61**: 801, 1953).



Polypoid Diseases of the Stomach¹

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ROENTGENOLOGY offers a most satisfactory clinical approach to the finding of small polypoid defects in and beneath the gastric mucosa. These polypoid defects may be produced by a large variety of gastric diseases. The problems associated with their differentiation have been impressed upon us by our experience in

festation of gastric disease by the appearance of something polyp-like. Just as adenomatous polyps may be pedunculated or sessile, so this wide variety of polypoid lesions range from a sessile configuration through complete pedunculation. According to Stewart (87), conversion from a wholly sessile plaque to a pedunculated

TABLE I: POLYPOID DISEASES OF THE STOMACH

Inflammatory	Tumors		Miscellaneous
A. Specific	A. Benign (after H. G. H. Richards, 77a)	B. Malignant	1. Sarcoid
1. Syphilis; gummata	1. Epithelial		2. Dermoid cyst
2. Tuberculosis	(a) Gastric origin		3. Aneurysm of gastric artery
B. Non-specific	(b) Ectopic origin	(1) Adenocarcinoma (stomach)	4. Echinococcus cyst
1. Gastritis	(1) Aberrant pancreatic rests	(1) Adenocarcinoma (pancreas)	5. Simple blood and lymph cysts
(a) Hypertrophic	2. Non-epithelial		6. Amyloidosis
(b) Polypoid	(a) Connective tissue origin		
(c) Localized acute edematous gastritis	(1) Fibromata	(1) Fibrosarcoma	
2. Inflammatory "fibroids" (eosinophilic granuloma)	(b) Smooth muscle origin	(1) Leiomyoma	
	(1) Leiomyoma		
	(c) Neurogenic	(1) Neurofibromata	
	(1) Neurilemmomata	(2) Neurofibromata	
	(d) Adipose tissue	(1) Lipomata	(2) Neurofibrosarcoma
	(1) Lipomata		(1) Liposarcoma
	(e) Vascular		(a) Hemangiosarcoma
	(1) Angiomata		
	Hemangioma		
	Lymphangioma		
	(2) Endotheliomata		
		Others: Lymphomata	

recent months, and we have been led to review the entire subject of polypoid "filling defects" in the stomach. The literature is voluminous. The following represents a condensation of the most important aspects. Refinements in equipment and technic and a demand for early diagnosis of gastric cancer have produced and will continue to produce greater skill in the detection and diagnosis of these lesions.

The phrase "polypoid disease" is purely descriptive and does not indicate any definite etiology. Rather it signifies a mani-

polyp is brought about chiefly by the muscular movement of the stomach, aided perhaps by the action of gravity. The surface of the lesion may be relatively flat or convex, and either smooth or irregular. The surrounding mucosa is usually normal, but may occasionally be atrophic or hypertrophic. The pedicle is often, in cases of tumor, composed not of tumor tissue *per se*, but rather of pulled-out or greatly thinned mucosa with varying amounts of submucosa.

Histologically these polypoid lesions

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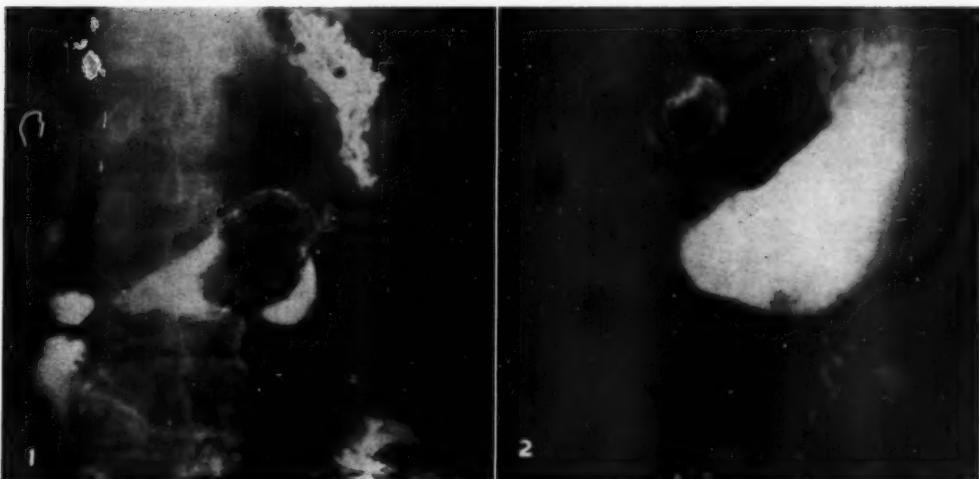


Fig. 1. Smooth polypoid filling defect in the antrum. The mass is large in relation to stomach size. There is no evidence of ulceration. Mucosa is thinned over the tumor and rugae are absent. *Polypoid adenocarcinoma of the stomach.*

Fig. 2. Smooth rounded defect in duodenal bulb. Elongation of the pylorus. Vague lucent defect in stomach along the greater curvature. *Benign gastric polyp prolapsed into the duodenal bulb in association with carcinoma of the stomach.*

may be segregated into several categories (Table I):

1. Inflammatory
 - (a) Specific
 - (b) Non-specific
2. Tumors
 - (a) Benign
 - (b) Malignant
3. Miscellaneous

To the clinician and to the patient the second group—the gastric tumors—represents the largest and the most important segment of this problem. In the inflammatory group serious complications are infrequent (95). For the most part the diseases in the miscellaneous group are rare, non-neoplastic, and of importance only for consideration in differential diagnosis. For the present, attention will be directed toward certain features of the polypoid neoplasms of the stomach.

SYMPTOMATOLOGY

In general, symptoms produced by polypoid diseases are vague or even non-existent until complications arise. As Rigler (79) has indicated, symptomatology depends upon the size, multiplicity, location,

and character of the lesions, and whether or not ulceration is occurring. Dailey and Miller (24) have noted that tumors which, because of their location or form, cause obstruction or bleeding will herald their presence early. As Matas (61) has noted, in rare instances any of the benign gastric tumors may assume the characteristics of the polyp. Due to their high incidence in the antrum or prepyloric area, these tumors are prone to prolapse into the pylorus, producing intermittent partial or complete obstruction. When this ensues, nausea, vomiting, and gastric retention occur. Further, the epigastric pain becomes more severe and cramp-like. Once the mucosa becomes adequately thinned over the polypoid lesion, ulceration may occur, with the onset of intermittent ulcer-like pain and associated epigastric distress. With ulceration, hemorrhage may ensue, with or without hematemesis (2, 86). Paul and Logan (72) have noted that the bleeding is more apt to be massive and similar to that of a peptic ulcer than of the oozing character commonly observed in carcinoma.

With malignant change, symptoms may gradually increase as the clinical picture

TABLE II: SUMMARY OF HARBOR HOSPITAL CASES OF POLYPOID LESIONS OF THE STOMACH

Case	Location	Symptoms
I. Leiomyoma (subserous)	Cardia	Painless hematemesis and melena
II. Adenocarcinoma, stomach	Body	Poor appetite, post-cibal vomiting
III. Adenocarcinoma (3 cm. with 1 cm. ulcer) sharply defined, looks like benign lesion	Lower part of body	Abdominal pain
IV. 1. Adenomatous polyp (2 cm. diameter, 1.5 cm. stalk), 0.5 ulcer on surface	Pylorus	
2. Scirrrous carcinoma throughout, point of origin lost	Throughout	Nausea and vomiting, anorexia
V. Leiomyoma (submucosal) (7 cm. diameter with 1 cm. ulcer)	Fundus	Severe gastrointestinal bleeding
VI. Adenocarcinoma with ulcer (5 × 5 cm.)	Body	Chronic bleeding from gastrointestinal tract with upper gastrointestinal symptoms
VII. Eosinophilic granuloma (1.5 cm. polypoid mass with 1.5 cm. base)	Antrum	Nausea and vomiting eight weeks prior to admission, intermittent febrile reaction since
VIII. Adenomatous polyp	Prepyloric	Epigastric pain, nausea and vomiting, severe emaciation. Proved duodenal ulcer two years earlier.
IX. 1. Adenomatous polyp; prolapse to bulb	Pylorus	Pyloric obstruction with past history of peptic ulcer
2. Adenocarcinoma, polypoid	Antrum	
X. Multiple adenomata	Body and antrum	Gastrointestinal upset; colicky pain and distension of six days duration.
XI. 1. Two polyps	Antrum	Pain in right upper quadrant. Hepatomegaly
2. Two carcinomas	Pars media	Distention
XII. Benign gastric polyp	Antrum	Painless jaundice of two weeks duration
XIII. Polypoid adenocarcinoma	Antrum	Epigastric pain seven weeks, partially relieved by food. Loss of weight

of inanition is superimposed on the findings described above.

REVIEW OF OUR MATERIAL

In our short-term experience, a group of 13 histologically proved cases of polypoid gastric lesions were available to us. The selection of carcinomatous lesions was limited to those presenting a true polypoid appearance and thus excluded those extensive fungating growths which involved the gastric wall as well as being endogastric (Table II). Among the 13 proved cases, there were 4 with only polypoid gastric carcinoma. These presented an appearance highly consistent with benign tumors. There were 5 cases of adenomatous polyps, 2 of which had prolapsed into the duodenal bulb and 3 were, in addition, associated with gastric cancer. The remainder represented infrequent miscellaneous lesions. A larger number of polypoid gastric lesions still remain unproved. Because of the relatively few histologically verified cases of this type available, no estimate of frequency is made from this series. For this information and that concerning the relationship between benign and malignant polypoid gastric

lesions, recourse is had to numerous published articles.

INCIDENCE OF POLYPOID GASTRIC NEOPLASMS

The frequency of polypoid diseases of the stomach varies according to the examiner, the types of examination, and the types of patients selected or studied (13, 15, 25, 33, 49, 80, 86, 87). The pathologist reports the greatest incidence of benign

TABLE III: INCIDENCE OF BENIGN TUMORS (AUTOPSY)

	No. of Cases	Per cent Benign
Rigler and Erickson	6,242	0.8
Dudley, Miscall and Morse	4,413	0.72
Lawrence	7,000	0.71
Stewart	11,000	0.43
Buckstein	21,026	0.04
Brown	18,200	0.003

polypoid neoplasms of the stomach. His figure reflects an overall study of the incidence. It includes numerous lesions of subroentgenographic size and asymptomatic as well as symptomatic cases. Reports by roentgenologists tend to concern themselves with selected series and types of patients. As Dudley (25) has indicated, the disparity between the reports of the roentgenologist and the gastroscopist *versus*

TABLE IV: INCIDENCE OF BENIGN TUMORS (ROENTGENOLOGY)

	No. of Cases	Per cent Benign
Rigler and Erickson	4,236	1.6
Havel	1,874	0.32
Spriggs and Marxer	4,424	0.25
Mason and Dwyer	4,000	0.07
Adolph	3,000	0.03
Holmes	30,000	0.02
Finesilver	43,200	0.01

mas rarely become malignant (87). There is some question as to whether a leiomyoma of the stomach undergoes such a change or is a leiomyosarcoma from the start. Golden and Stout (37) have indicated that one can never be entirely certain that any leiomyoma is necessarily benign. They favor the designation malig-



Fig. 3. Multiple polypoid defects in antrum of stomach. Grossly the distal two appeared obviously benign while the proximal pair were thought to be polypoid carcinomas. Histologically all were *benign adenomatous polyps*.

the pathologist, so far as figures are concerned, is indicative to some degree of the incidence of non-symptomatic lesions (55, 3).

Golden (36), calling on the statistics of Stout, indicates that approximately 25 per cent of gastric carcinomas may be of this exophytic or polypoid type (see Tables III and IV).

RELATIONSHIP TO CANCER

The importance of the discovery and identification of polypoid gastric lesions lies in the tendency for the benign gastric tumors to undergo malignant change, or, in many cases, in an association of these lesions with an existing malignant growth (17, 26, 37, 58, 63, 71, 73, 80, 97). Lipo-

nant leiomyoma rather than leiomyosarcoma, since the latter connotes high malignancy, which for the most part does not exist in the stomach. They further indicate that classification of these tumors into benign and malignant is difficult because poorly differentiated leiomyomata frequently do not display clinical evidences of malignancy, while occasionally a well differentiated tumor has grown by infiltration and metastasized. Simple adenomatous polyps, according to Stewart, whether single or multiple, must be accepted as definitely precancerous, although the association is apparently less intimate than that existing in the large intestine. Figures compiled from several sources reveal this apparent relationship and indi-



Fig. 4. Multiple lucent defects in the body of the stomach. (Tiny more lucent defects in the prepyloric area are artifacts—air.) *Multiple adenoma* of the stomach.

cate that malignant change occurs in from 3 to 14.4 per cent of polyps (4, 17, 49, 56, 79, 87).

Information concerning a similar relationship between non-epithelial tumors and cancer is less well established but occasional reports are suggestive (37, 48, 77). Golden and Stout, reporting on smooth-muscle tumors, stated that of 32 involving the stomach 5, or 15 per cent, were malignant upon histologic examination. Ransom and Kay (77) found that of 7 gastric neurogenic tumors 3 were sarcomatous at the time of evaluation.

It would thus appear that the tendency for malignant change or for malignant association in this group of polypoid tumors of the stomach is well established and affords the principal indication for the identification of these lesions and their differentiation from cases classified in the other two groups as indicated above (see Table V).

LOCATION

Polypoid lesions of the stomach may arise and present anywhere within the gastric lumen. Their frequency is greater, however, in the region of the pylorus and antrum. Balfour and Henderson (4), Moore (65, 66), Eliason and Wright (28), Lawrence (49), and Marshall and Aronoff (57) have all indicated the tendency

TABLE V: RELATION OF GASTRIC ADENOMATOUS POLYPS AND CANCER

	Cases of Polyps	Cases of Malignant Polyps	Polyps with Associated Gastric Cancer
Rigler	15	2 (13.3%)
Stewart	47	3 (6.4%)	13 (28%)
Balfour and Henderson	58	2 (3.4%)	5 (8.6%)
Carey and Hay	71	5 (7.0%)
Lawrence	50	3 (6%)	6 (12%)
McManus and Sommers	45	4 (8.8%)

for benign epithelial polypoid tumors to occur in the antral and pyloric areas. Non-epithelial tumors, likewise, have a predilection for these areas (2, 23, 37, 77, 90). Ectopic pancreatic rests are more frequent on the greater curvature in the antrum (32, 53). As might be expected, the malignant counterparts present no variation in respect to preference of location (51, 59, 71). In summary, benign and malignant polypoid tumors of the stomach occur more frequently in the antrum and prepyloric portions.

With these observations in mind, a consideration of any peculiar characteristics of individual polypoid diseases of the stomach which may aid in their differentiation should follow.

DIFFERENTIATION

The differentiation between benign and malignant polypoid diseases is not absolute (29, 37, 63), but certain characteristics, when present, tend to favor one or the other possibility.

A static lesion is usually benign, as is occasionally a very slowly growing one. The borders are regular, smooth, and occasionally nodular, rounded, and sharply circumscribed. A stalk is frequently pres-

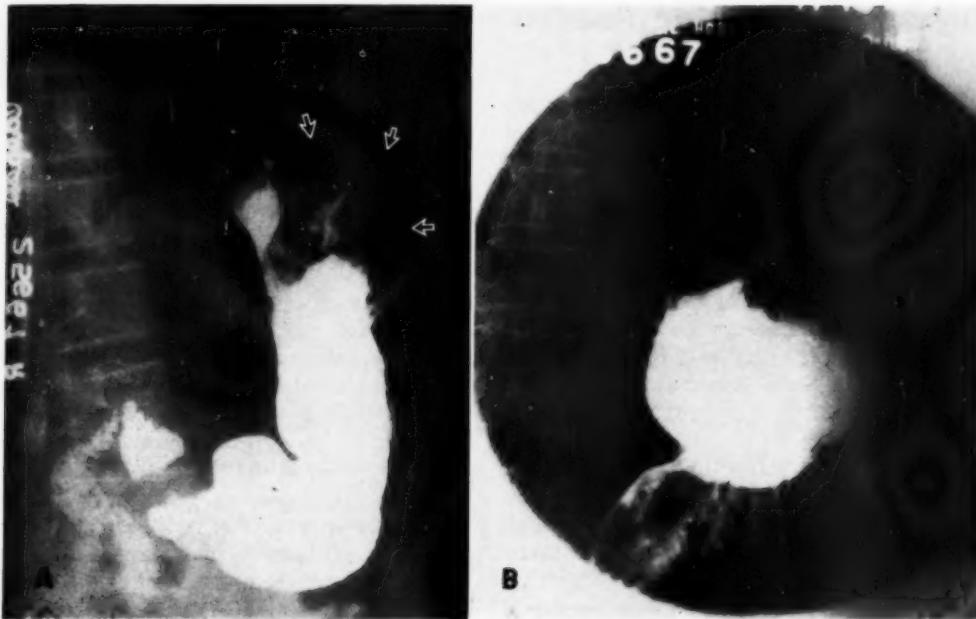


Fig. 5. Large filling defect in the fundus of the stomach, seen only in the lateral view (A) as a vague alteration in the normal rugal pattern. The defect is completely obscured by the barium meal in the anteroposterior view (B). *Large leiomyoma of the gastric fundus with ulcerations.*

ent. Rugae are generally normal but may be thin over the tumor surface.

Growth, especially rapid growth, is characteristic of malignant lesions. Margins are more apt to be irregular and less well defined. Pedicle formation is infrequent. Ulcers due to tumor necrosis may be found and present a bizarre appearance. Most significant is the absence or reduction of peristalsis and loss of pliability of the gastric wall at the site of involvement. Except for tuberculosis, syphilis, and amyloid disease (18, 21) of the stomach, these latter features are extremely rare in benign lesions. Thickening of the rugae is reported in gastritis, amyloidosis, and syphilis (84). Rugal thickening and nodularity are reported in tuberculosis (83). Stiffening and thickening of the rugae with or without nodularity and/or irregular destruction of the mucosal folds are rather characteristic of malignant disease.

The identification of specific polypoid lesions is extremely difficult, as they may bear a close resemblance to one another.



Fig. 6. Large oval lucent defect in antrum. Note the smooth borders and unaltered rugae of opposite wall. *Large polypoid adenocarcinoma of gastric antrum.*

Certain features, however, may be more suggestive of one lesion than another. In general, the age and sex of the patient are of little help in differentiation.

Gastric tuberculosis (9, 35, 38, 70, 83, 88, 95) and syphilis (52, 92) are extremely uncommon as causes of polypoid disease. While peristalsis and pliability may be de-

creased in these conditions, the decrease is generally less than would be the case with a carcinoma of comparable size. Ulcerations and hyperplastic infiltrations are common in tuberculosis. The presence of tuberculosis elsewhere and of tertiary syphilitic involvement are the most important indications of the specific diagnosis. Response to antisypilitic therapy is significant (8).

In the common non-specific inflammatory polypoid diseases, rugae are thickened, with normal pliability and minimal variation in peristalsis. Gastroscopy is especially valuable in differentiation of these diseases (68).

Adenomatous polyps (17, 25, 26, 31, 40, 49, 54, 56, 63, 64, 65, 73, 86, 87, 97) are small, sometimes multiple, and not distinctive in appearance. Aside from carcinoma, which according to the literature constitutes approximately three-fourths of the polypoid lesions, the adenomatous polyp is the most frequently encountered epithelial tumor of the stomach.

The leiomyomata (6, 19, 29, 37, 48, 50, 55, 58, 59, 64, 71) range from very small to extremely large, smoothly rounded, or lobulated tumors; they may be intramural, endoluminal, or exogastric. They are commonly ulcerated.

The neurogenic tumors (5, 77, 90, 94) are less common than the leiomyomata, which they resemble, though they are more often exogastric.

Lipomata (2, 45) are infrequent. They have been reported as showing the following unique findings: translucency of the tumor (85), a doughy mass (3), and slight mobility within the gastric wall (29).

Rare vascular tumors may show the presence of phleboliths within their confines.

Eosinophilic granulomas (12, 82) have been renamed inflammatory fibroids by Bullock (16), by virtue of the inflammatory connective tissue present within the tumor and the associated inflammatory cell response, particularly the high eosinophil cell response. Roentgenologically, the picture varies from that of a simple polyp to an appearance consistent with localized

hypertrophic gastritis. Some authors have described a peripheral eosinophilia in association with these lesions.

Aberrant pancreatic tissue (30, 53, 93) may present as a small, sometimes umbilicated polypoid tumor. Pancreatic duct visualization, permitting a diagnosis, has been reported (47).

Carcinoma is the most frequent polypoid tumor and best demonstrates the characteristics of malignant polypoid disease (36, 62), namely, irregularity, lack of flexibility, absent or diminished peristalsis, rugal alteration, and luminal encroachment.

Sarcomas of non-lymphomatous origin represent only a small fraction of malignant polypoid disease (48, 51, 57, 59). They occur in a slightly younger age group. Roentgen evidence of malignancy is often absent or equivocal, seldom clear-cut or definite.

Lymphomatous polypoid disease (10, 14, 22, 29, 34, 54a, 57, 58, 71, 75, 96) represents approximately two-thirds of the non-epithelial malignant tumors. This condition is thought to be indistinguishable from carcinoma and indeed carcinoma is by far the most frequent preoperative diagnosis. The following features, however, may suggest lymphoma: (a) systemic or hematologic manifestations of lymphoma; (b) in general, a better physical condition and occurrence in a slightly younger average age group; (c) a palpable smooth tumor in a young person; (d) less disturbance of peristalsis and flexibility than with carcinomatous lesions of corresponding size; (e) rapid response to irradiation.

The rare miscellaneous polypoid entities usually have other organ or systemic manifestations to suggest the diagnosis (64, 76).

SUMMARY

1. The etiologic possibilities of polypoid gastric lesions have been enumerated.
2. The diagnostic difficulties and possibilities have been emphasized and points of differentiation have been given be-

tween the various polypoid diseases of the stomach.

3. The incidence of polypoid diseases of the stomach has been discussed. Polypoid carcinoma is by far the most common, with polypoid sarcomas second and benign adenomatous polyps third in frequency.

4. The incidence of malignancy in polypoid gastric lesions is high.

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SUMARIO

Afecciones Polipoideas del Estómago

La expresión "afecciones polipoideas" del estómago es puramente descriptiva y no indica ninguna etiología dada. Tiene aplicación a varias lesiones de aspecto polipoideo, comprendiendo procesos inflamatorios (específicos y anespecíficos), tumores (benignos y malignos) y un pequeño grupo de extrañas dolencias que no son neoplásicas. Con mucho, la más frecuente de esas lesiones polipoideas es el carcinoma polipoideo al que siguen en orden el sarcoma polipoideo y los pólipos adenomatosos benignos.

La importancia del reconocimiento e identificación de las afecciones polipoideas del estómago procede de la tendencia de los

tumores benignos a experimentar alteración maligna o a asociarse con un tumor maligno ya presente. Una situación estática, bordes regulares y lisos y la presencia de un tallo sugieren una lesión benigna. Un crecimiento rápido, bordes irregulares y falta de tallo son más típicos de enfermedad maligna. Aun más características de malignidad son la reducción del peristaltismo y la pérdida de la flexibilidad de la pared gástrica en el sitio afectado.

La identificación de las lesiones polipoideas específicas del estómago es sumamente difícil. Menciónanse algunas características que pueden ser de ayuda en ese sentido.

DISCUSSION

Edward L. Jenkinson, M.D. (Chicago, Ill.): Drs. Ottoman and Woodruff have successfully accomplished the most difficult task of reviewing the extensive literature on the subject of polypoid filling defects of the stomach. The papers published on this subject are, indeed, many and varied, and a review of this type serves to correlate much scattered and valuable information. The conclusions arrived at assist the radiologist in evaluating the etiology of a polypoid lesion of the stomach that he might encounter in his work, so that he may indicate to the referring physician the direction of the subsequent action to be taken.

There is no questioning the statistics that place carcinoma as the most frequent polypoid tumor of the stomach. The authors state that lymphomatous polypoid disease represents approximately two-thirds of the non-epithelial malignant tumors of this organ. It is admittedly difficult to distinguish primary lymphosarcoma of the stomach from poly-

poid carcinoma. This has been the subject of many investigations, including one recently made at our hospital. It would seem that at no time should the tentative diagnosis of carcinoma or far advanced carcinoma of the stomach deter one from further studies to determine the possibility of a lymphomatous lesion existing instead. Primary lymphosarcoma presents a far better prognosis than the extremely discouraging one of a true polypoid carcinoma. Adequate roentgen therapy may produce prolonged alleviation of symptoms and possibly an occasional cure. Local excision has been known to produce long survivals. It is advisable that irradiation follow surgery, as most diagnoses will be made surgically.

The statement that benign adenomatous polyps are the third most common form of polyp naturally brings to mind the subject of malignant change in adenomatous polyps. The authors place these figures at anywhere from 3 to 13 per cent. Also to be

considered is the much greater percentage of gastric cancer associated with adenomatous polyps, as found in the works of Stewart, Lawrence, and Balfour and Henderson. Their statistics suggest that apparently benign polypoid lesions of the stomach should be treated in exactly the same manner as polyps of the large bowel.

Our experiences at St. Luke's Hospital regarding the relative frequency of polypoid disease, and the high percentage of carcinoma among the polypoid tumors of the stomach, does not differ significantly from that determined at other institutions. I would like to mention, however, an unusual case encountered during this past year of multiple gastric ade-

matous polyps in sisters, one of whom was treated at the University Hospital in Philadelphia in 1931 by subtotal gastric resection and still remains asymptomatic at the present time. The younger sister was examined at St. Luke's Hospital in the late Spring of 1953, and the diagnosis of multiple gastric adenomatous polyps was made.

In closing I should like to cite another recent interesting case at our hospital in which the demonstration, with confirmation by subsequent examination, of multiple adenomatous polyps was made. The patient was a seventy-six-year-old male with hematemesis and weight loss, but no polyps could be demonstrated at the time of surgery.



The Potential Hazard of Enemas in Patients with Hirschsprung's Disease¹

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IT WAS recently our tragic experience to have one of our patients, a two-year-old girl with a megacolon, die while receiving a barium enema. The cause of death was not immediately apparent. A survey of the literature was then made and our own files were reviewed in an attempt to throw some light upon the cause of this accident and the frequency with which it happens.

As early as 1893 a case was described in an eleven-year-old boy with a history of abdominal distention and constipation from birth who died suddenly during administration of an enema. At autopsy the transverse and descending colon were found to be dilated, gradually narrowing down to a normal distal sigmoid and rectum. The cause of death was thought to be "embarrassment of the enfeebled heart action by the distention of the abdomen" (7). In 1913, Neugebauer (5) reviewed a case described by Nepilly in which a child experienced convulsions and a cold sweat, and died shortly after passing a stool containing fluid that had been administered as an enema several hours previously. There had been no return of fluid following the enema prior to this time. Neugebauer thought that death was of cardiac origin as a result of displacement and compression of the heart and the toxic effect of resorbed products of putrefaction from the intestine.

Moncrieff and Crichlow (4) reported the sudden death of a patient with Hirschsprung's disease who had been receiving enemas with poor results. Autopsy revealed semifluid feces in the colon, but no cause of death.

Three sudden deaths of unknown etiology

in patients with megacolon were reported by Whitehouse and Kernohan (8). Burnard (1) also had 7 patients who died suddenly of unknown cause. It is possible that these deaths may have resulted from enemas.

Hiatt (2) reported that 60 per cent of a series of 42 patients with congenital megacolon had reactions consisting of extreme weakness, anorexia, and sweating for a variable time following administration of water enemas. In some cases an acute shock-like state and death occurred. Richards and Hiatt (6) later presented a series of 7 cases of severe reactions, including 2 deaths, following hypotonic enemas. The first patient was a four-year-old girl who had convulsions and became unconscious after two large colonic lavages and a soapsuds enema on the two preceding days. She became cyanotic and died. Postmortem examination revealed cerebral and pulmonary edema. A typical megacolon was present, containing 3.2 liters of fluid. The second death was that of a three-year-old boy, who died shortly after receiving a soapsuds enema and Prostigmine. The other reactions were in children ranging in age from fifteen months to six years; with one exception the patients were two years of age or over. These authors believed that the reactions were for the most part due to water intoxication.

Jolleys (3) reported the death of a three-year-old boy with Hirschsprung's disease approximately twenty hours after a barium enema had been administered. After completion of the enema the patient was cold, collapsed, and sweating. He voided large quantities of diluted urine, vomited dark

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colored fluid, and about seven hours later lapsed into coma, became cyanotic, began to have generalized convulsions, and died. It seemed probable that death was the result of intoxication.

We have collected 4 cases of megacolon in which there was sudden death from unknown cause, and 1 case in which a shock-like state followed an enema but the child recovered.

CASE I: J. F., a two-year-old white female, had suffered from constipation since the age of one month. She had been treated with plain water enemas daily until the age of one year, after which enemas were given every other day. At the age of nine months she was hospitalized three times in close succession for the removal of fecal impactions. She was poorly developed and underweight, was unable to stand alone, and had never talked. Her abdomen was very protuberant. She had frequent upper respiratory infections; the latest had occurred about two weeks before she was seen at the University of California Hospital, and was accompanied by cervical adenopathy, which had subsided under treatment.

The heart rate was 110 and a Grade II systolic murmur was present, maximal at the third intercostal space to the left of the sternum. Laboratory examinations revealed: hemoglobin 5.0 gm.; red blood cells 2,700,000; white blood cells 18,600, with 88 per cent lymphocytes, 10 per cent polymorphonuclears and 2 per cent monocytes; sedimentation rate 46 mm. in an hour (uncorrected); packed cell volume 21 mm. The clinical impression was megacolon, nutritional anemia, and a functional heart murmur.

A barium enema consisting of a suspension of barium sulfate in tap water was administered with the patient immobilized on a plywood frame. The flow was initiated with the enema can at a height of 3 feet from the table top. The barium suspension passed slowly to the transverse colon, revealing a markedly dilated lumen, but because it could not be induced to pass to the proximal part of the colon, the enema can was raised to 5 feet from the table top. Approximately 750 c.c. of barium suspension was introduced before it was decided to discontinue the attempt to fill the colon completely. The child had cried lustily throughout the examination, which lasted about five minutes. At the conclusion of the procedure she suddenly stopped crying and became unresponsive; irregular, shallow respirations developed, and no pulse or heartbeat could be obtained. Attempts at resuscitation were unsuccessful.

Autopsy disclosed a primary myocarditis, interstitial pneumonia, and mild pulmonary edema. The colon was markedly dilated and hypertrophied.

CASE II: M. D., a white male of five and a half years, was originally admitted to the Sonoma State Home Hospital in shock, with cold, ashen skin, a rapid, feeble pulse, and abdominal distention. During the ensuing twenty-one days, he suffered from recurrent episodes of abdominal distention, for which he received Wangensteen suction and several tap-water and soapsuds enemas. On the twentieth day of hospitalization, marked abdominal distention suddenly developed, followed by vomiting which was not relieved by Wangensteen suction and a rectal tube. Neostigmine, 0.3 c.c., was administered intramuscularly. Seven hours later an enema of 250 c.c. of tap water was given, which was subsequently siphoned off. The child exhibited tachycardia, rapid respirations, slight cyanosis, and a temperature of 101° F. He appeared to be in shock. A clysis of 500 c.c. of 5 per cent dextrose in water solution followed by 500 c.c. of Ringer's lactate solution was administered, shortly after which death occurred.

CASE III: L. H., a girl of two and a half years, was admitted to the University of California Hospital with a temperature of 104° F., hematemesis, and abdominal pain of twenty-four hours duration. She had suffered from constipation all of her life and had required purgatives and as many as two or three enemas daily. She had been hospitalized twice in the preceding six weeks for what was diagnosed as acute bowel obstruction, which was relieved by colonic flushes.

Two hours after admission to the hospital the patient was given a colonic flush of unknown composition, which was expelled. She received also a clysis of 250 c.c. of 5 per cent dextrose in saline solution and was given 500 c.c. of the same solution intravenously. Ten hours after admission her condition became much worse; she appeared to be in shock and lapsed into a coma. Another colonic flush was given, with 1,000 c.c. of saline and 300 c.c. of 5 per cent dextrose in saline, followed by 100 c.c. of saline intravenously. In spite of plasma and blood transfusions, death ensued approximately nine hours later. A blood count shortly after admission to the hospital revealed: red blood cells 7,040,000; white blood cells, 19,300, with 68 per cent polymorphonuclear neutrophils, 1 per cent eosinophils, 1 per cent basophils, 29 per cent lymphocytes, and 1 per cent monocytes.

Autopsy revealed a congenital megacolon with some ulceration of the mucosa. The cause of death was not given.

CASE IV: R. M., a girl of four and a half years, was admitted to the University of California Hospital with a history of constipation for five days, with vomiting and progressive lethargy for two days. She had been given a "soda enema" the day before entering the hospital. Her blood pressure was 40/?, temperature 100° F., pulse 160, respiration 60. She

appeared dehydrated and in a moderately severe state of shock.

A warm saline enema and clysis of normal saline were given. Three hours after admission the child became slightly cyanotic, vomited a brown material that gave a mildly positive guaiac reaction, and died.

Laboratory findings were as follows: hemoglobin 22 gm.; white blood cells 16,250, with 71 per cent neutrophils, 26 per cent lymphocytes, and 3 per cent monocytes.

Autopsy revealed a congenital megacolon, hyperplasia of the thymus, and mild adenomatous hyperplasia of the adrenals.

CASE V: F. M., a three-year-old boy, gave a history of intermittent constipation and diarrhea since shortly after birth. In the ward he was maintained with saline enemas and colonic flushes when the enemas failed to produce results; the composition of the fluid used for the flushes was not stated in the hospital record. Several medications were given intermittently, including Mecholyl in varying dosages throughout most of the course and Prostigmine for a short time.

Shortly after a colonic flush was started, the child went into shock, with pallor, cold extremities, vomiting, imperceptible pulse, and a heart rate of 20-24 per minute. Atropine and adrenalin were given, after which he improved.

DISCUSSION

Congenital megacolon is frequently a fatal disease. Hiatt was impressed by the rarity of the condition in adult patients and investigated the cause of death. In the newborn death was occasionally found to be caused by perforation of the sigmoid as a result of obstruction. Perforation after the neonatal period was rare, although mucosal ulceration was frequently present.

All 4 of our patients who died were severely debilitated. One had a hemoglobin of 5.0 gm. and a myocarditis. Two had reactions that can be directly related to enemas: one of these died during the course of a barium enema, and the other had a severe shock-like episode while receiving a colonic flush. The other 2 patients died suddenly of unknown cause. They were dehydrated, had fever, and showed evidence of shock. Each had received many enemas; 2 had been given Prostigmine or similar drugs, and in 1 (Case V) Prostigmine intoxication was in all likelihood a major element. It is pos-

sible that the enemas contributed to death in these cases.

It appears to have been established that enemas can precipitate severe and often fatal reactions in patients with Hirschsprung's disease. The mechanism by which this is brought about, however, has not been adequately explained. Hiatt believes that death is a result of water intoxication. In support of his theory, he cites the similarity in symptomatology between these patients and patients having the syndrome of water intoxication. He also made serial plasma electrolyte studies on several megacolon patients following the instillation of tap water into the colon and demonstrated a rapid diffusion of water into the circulating fluid, causing a precipitous fall in the plasma concentration of sodium, proteins, and specific gravity. The electrolyte dilution occurred within fifteen minutes in 1 case. The conclusion was reached that the essential disturbance producing reactions in megacolon patients was a state of low sodium shock.

Megacolons have a much larger absorptive surface than normal colons, and multiple superficial ulcerations of the mucosa are frequently present, both factors adding to the rate of absorption. Absorption from the intestine has been shown to vary directly with the hydrostatic pressure of its contents. The hypertrophied muscular wall and partial obstruction to evacuation produced by the "aganglionic segment" of a megacolon are capable of producing a very high intraluminal pressure. Because of the usual presence of a large amount of fecal material that interferes with filling, it is common practice to use a high hydrostatic pressure in introducing enemas in these patients, which further increases the intraluminal pressure. Prostigmine and similar drugs, often used in these cases, also increase the muscular contractions of the colon.

Thus a good case can be made for the implication of water intoxication as the important factor in the post-enema reactions suffered by patients with megacolon. Some features of these reactions, however,

are not readily explained by this theory. Why are the reactions produced in some patients and not in others? Why will a child be able to take as many as two enemas daily for two years or eleven years without having any obvious ill effects and suddenly go into shock and die following a procedure that was similar in all respects? Some of the reactions were similar to those encountered in Prostigmine poisoning (Richards and Hiatt; Case V in our series). Furthermore, we have instilled tap water into the colons of 3 patients with megacolon and made serial observations on the plasma electrolytes without being able to show a significant decrease in their concentration. There was some evidence of water absorption as demonstrated by the

inhibition of the frog's heart could be induced by repeated gentle taps upon the intestine.

In megacolons there is a deficiency or absence of the normal myenteric plexuses for varying distances in the distal part. Thus the disease is primarily a neurologic disturbance, and it is conceivable that an altered or exaggerated reflex could be produced that would cause cardiac arrest and shock. The normal reflex might also be increased in magnitude because the distention is greater than in normal colons.

Irrespective of the cause of these reactions, it is important to know that they can occur, to make an attempt to prevent them, and to be able to overcome them once they become manifest. Every effort should be

TABLE I: CONCENTRATION OF PLASMA CONSTITUENTS BEFORE AND AFTER ENEMAS IN PATIENTS WITH MEGACOLON

	Adult male 20 years old 2,500 c.c. tap-water enema				3-year-old female 500 c.c. tap-water enema				Same 3-year-old child 1,500 c.c. tap-water enema			
	25 min. later		60 min. later		75 min. later		20 min. later		50 min. later		120 min. later	
	Before		Before		Before		Before		Before		Before	
Hgb., gm.	17.3	16.6	16.7	18.0								
PCV, mm.	51.	46.	46.	48.	33.	35.	35.	33.5	33.5	35.	31.5	30.5
Plasma												
Sp. Gr.	1.030	1.028	1.029	1.030								
Na, meq/l	140	144	142	142	143	145	144	143	132	136	140	132
K, meq/l	4.0	4.0		4.0	4.0	4.2	4.1	4.2	4.3	4.0	4.0	3.9
Cl, meq/l	94	94	97	95								
CO ₂ , meq/l	27.0	27.1	26.1	29.7								

drop in hemoglobin, hematocrit, and specific gravity in 1 case, but the body is apparently able to compensate for minor dilutions and maintain a stable electrolyte concentration (Table I). We do not know why we have been unable to duplicate Hiatt's results showing electrolyte dilution. It may be that we have not examined a sufficient number of patients, and that some are not capable of maintaining a constant electrolyte concentration. Further experiments of this type need to be done.

The possibility must be considered that some or all of these reactions are a result of mechanical distention of the colon. It is well known that reflex inhibition of the heart and shock can be induced by appropriate stimuli to the afferent nerves. Goltz showed many years ago that reflex

made to see that the patient's general condition is good before the enema is given. This precaution is particularly indicated if a barium enema is contemplated, as a large volume of fluid is frequently injected. Our first patient had a severe anemia, myocarditis, and pneumonia. Three other patients were dehydrated. If the patient has been receiving Prostigmine or similar medication, it should be eliminated or the dosage reduced prior to administration of the enema.

Although it has not been conclusively demonstrated that the reactions are a result of water intoxication, it is probably wise to use a saline solution for the enema. Barium sulfate, being insoluble, exerts no osmotic pressure. An isotonic saline solution can be approximated by adding 2 level teaspoons of sodium chloride (approxi-

mately 9 gm.) to a liter of fluid. Hiatt advised the use of a 7 per cent gelatin solution, but this should not be used in the presence of barium, as it quickly forms a gel.

Following the enema, as much fluid should be recovered as possible. This may require a rectal tube and siphoning or suction if a large amount remains in the colon.

In performing a barium enema study, it is usually not necessary to fill the entire colon to diagnose Hirschsprung's disease. The diagnosis can usually be made by demonstration of a narrowed rectum and rectosigmoid, associated with a pronounced dilatation of the descending colon and varying lengths of the sigmoid colon. We have recently examined a patient in whom a markedly distended colon was demonstrated without evidence of a narrowed distal segment. The examination was repeated, with only a small amount of barium sulfate suspension, and the narrowed rectum and distended sigmoid were well visualized (Fig. 1).

It should also be emphasized that the hydrostatic pressure of the fluid being introduced into the colon should not be excessive. In our first case, the enema can was raised to 5 feet above the roentgenoscopic table. A height of 2-feet is usually sufficient, and 3 feet should not be exceeded.

If all of these precautions are undertaken and a reaction nevertheless occurs, the patient should be treated symptomatically for shock. Normal saline, plasma and blood should be given intravenously.

SUMMARY

Severe reactions and deaths have occurred not infrequently in patients with Hirschsprung's disease during or immediately following administration of an enema.

The cause of these reactions has not been conclusively demonstrated, but some evidence has been provided to suggest the possibility of water intoxication due to rapid absorption of water from the colon. It is also possible that reflex cardiac inhibition



Fig. 1. A. Roentgenogram of the rectum and rectosigmoid with the entire colon distended. The rectum and rectosigmoid are dilated.

B. Spot film of the rectum in the same patient taken as soon as the barium column had reached the mid-sigmoid. The rectum is narrow. The opaque shadow above the rectum is the markedly dilated sigmoid.

and shock may be produced by abnormal distention of colon.

It is recommended that isotonic saline solution be used in enema studies in patients in whom Hirschsprung's disease is suspected. It is also recommended that the smallest amount of solution necessary be introduced under low pressure, and that as much as possible of the fluid be recovered after the procedure has been completed.

Five cases are reported.

NOTE: We wish to express our appreciation to Louise A. Yeazell, M.D., for providing us with some of the cases, and to Peter H. Forsham, M.D., for the use of his facilities to determine the serum electrolyte concentrations.

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SUMARIO

El Riesgo Potencial de las Enemas en la Enfermedad de Hirschsprung

Bastantes veces ha habido reacciones graves y muertes, al administrarse una enema o inmediatamente después, en sujetos que padecían de la enfermedad de Hirschsprung. No se ha demostrado en forma terminante la etiología de esas reacciones, pero hay algunos datos indicativos de que la causa puede ser una intoxicación hídrica debida a rápida absorción de agua por el colon. También es posible que la distensión anormal del colon pro-

duzca inhibición cardíaca por reflejo y choque.

Recomiéndase que se use solución salina isotónica al verificar estudios con enemas en pacientes con la enfermedad de Hirschsprung, que se introduzca a presión baja la mínima cantidad de solución necesaria y que se retire todo el líquido posible una vez terminado el procedimiento.

Presentan 5 casos, comprendiendo 4 fallecimientos.

DISCUSSION

Everett L. Pirkey, M.D. (Louisville, Ky.): First, I would like to say that I think it is well for this subject to be brought before radiologists.

In a brief review I found nothing in the radiologic literature concerning this particular hazard. It is worth while for all of us to bear it in mind. We should also keep in mind the role of the radiologist in the examination of these patients. Our purpose is to find the narrow segment which is somewhere in the rectosigmoid area. Filling beyond the sigmoid, therefore, is not indicated. To reduce any complications that may develop in administration of such enemas we should mix barium with normal saline solution and we should probably call this examination in patients with Hirschsprung's disease a "sigmoid study" rather than a "colon study." That may keep us from putting too much material into the colon at the time of examination.

Benjamin Felson, M.D. (Cincinnati, Ohio): I would like to say a few words about Hirschsprung's disease, and particularly to mention 2 cases that we have seen. In the first patient, a newborn infant, a perforation of the colon resulted from a barium enema and at autopsy the segment through which the perforation had occurred showed absence of ganglion cells.

The second instance might possibly be related to the condition described by Dr. Steinbach and his co-workers. The patient was an elderly adult who had had four previous bouts of volvulus of the sigmoid reduced by rectal intubation. During a fifth episode reduction by passage of a large rectal tube was again attempted. At the moment of decompression of the colon the patient died. This case suggests the possibility of a reflex mechanism as the cause of death in such cases.

Hodgkin's Disease

A Review of Two Hundred and Sixteen Cases¹

ROMEYN J. HEALY, COL. M.C.,² HAROLD I. AMORY, COL. M.C.,³ and MILTON FRIEDMAN, M.D.⁴

THIS STUDY COVERS 216 cases of Hodgkin's disease treated at Walter Reed Army Hospital from 1938 through 1948. In every instance the diagnosis was established by histologic study of an excised lymph node.

In view of present knowledge regarding Hodgkin's disease, it is believed that its best management is based on the concept that it is a malignant neoplasm. The pros and cons of an infectious granulomatous process *versus* a malignant neoplastic process cannot be settled by the practicing physician. Certainly, to date, the handling of Hodgkin's disease as an inflammatory condition has done nothing but delay its treatment as a cancer. Study of any of these cases from the onset of the disease, through its course, to the postmortem findings will convince one that it meets all the criteria of cancer.

The high incidence of primary involvement of a single lymph node, or a small group of nodes, lends support to the belief that Hodgkin's disease is unicentric in origin. This is corroborated by the relatively higher survival rate of patients with single lesions (Stage I).

All patients in this series were treated primarily with x-ray irradiation. A small percentage, about 10 per cent, were also given nitrogen mustard sometime during the course of their illness.

DIAGNOSIS

Even though the watchword in handling cancer today is "early diagnosis," which means histologic confirmation of the clinical diagnosis, the question of performing a biopsy in a given case is often handled with indecision and delay. The high per-

centage of Stage III cases found in this series bears this out.

In 74 per cent of the patients in this series the first sign of the disease was enlargement of a lymph node in the cervical chain. The bulk of these nodes were found in the inferior region of the cervical lymphatics.

Indications for a lymph node biopsy are: (a) an enlarged lymph node, chiefly in the lower cervical chain; (b) persistence of the enlargement for three weeks or more; (c) absence of a regional inflammatory lesion as a cause for the adenopathy.

Regression of adenopathy spontaneously or during antibiotic therapy is frequently misleading. Periodic examinations will usually reveal the regression to be partial, and enlargement of the same node or adjacent lymphatics will reappear. Another potential pitfall is the histopathological diagnosis of lymphadenitis or reactive hyperplasia. When this occurs, the physician should re-examine the patient for adenopathy every three months. This precaution will more often lead to a definitive diagnosis of Hodgkin's disease in the early phase.

CLINICAL CLASSIFICATION

In order to evaluate properly any method of therapy for malignant neoplastic disease, a suitable clinical classification should be used. Each case should be staged at the time of initial examination.

The following clinical classification of Hodgkin's disease was employed in this series:

Stage I: Disease limited to a single lymph-node group, or a sin-

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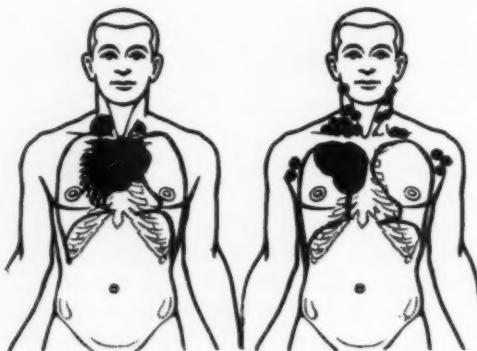


Fig. 1. Patients with widespread Hodgkin's disease (Stage III) who have survived more than five years. In the patient on the left, the disease was diffusely infiltrating the lung.

gle lesion of any organ, without constitutional symptoms.

Stage II: Disease limited to two adjacent lymph-node groups, or a single organ lesion plus regional lymph-node involvement, with or without constitutional symptoms.

Stage III: Involvement of two separated lymph-node groups or multiple groups of lymph nodes, and/or more than one organ involved, with constitutional symptoms.

The high incidence of cervical adenopathy, chiefly in the inferior half of the cervical chain, was striking. It is also possible that the cases listed as showing initial adenopathy in the mediastinum or axilla really had an earlier origin in the cervical lymph nodes. This initial adenopathy, being unnoticed or ignored by the patient, would undergo spontaneous regression and medical care would not be sought until evidence of the disease developed in the mediastinum or axilla.

The involvement of cervical nodes initially in 74 per cent of our series suggests that the pharynx may have been the site of the primary tumor. Further investigation is necessary, however, in order to determine whether or not there is a primary tumor and whether the disease is actually unicentric in origin.

TABLE I: AGE AND SEX INCIDENCE

Age (years)	No. Cases	Percentage
1-19	12	6
20-29	145	67
30-39	49	23
40-59	9	4
60+	1	0.5
Males, 197*		Females, 19

* The preponderance of males in the 20-29 year group is due to the fact that the patients were drawn from a military population.

TREATMENT

The relative percentage of five-year survivals substantiates the opinion that in Hodgkin's disease the primary treatment should be aggressive x-ray irradiation. The details of x-ray therapy are well known to the radiotherapist. The following principles, however, may be stressed.

1. Deliver a tumor dose of 1,500 r in one week; up to 2,500 r in three weeks; for some of the more resistant lesions, a total tumor dose up to 4,000 r.
2. In Stage I cases, the entire group of involved lymph nodes should always be treated through a large field to cover the entire anatomical region.
3. In Stage I cases with organ involvement, as of the bowel or stomach, the organ should be excised or irradiated and the adjacent group of regional lymph nodes irradiated.
4. In Stage II cases, the involved regions plus the adjacent group of lymph nodes should be irradiated.
5. In Stage III cases, the largest group in this series, all the involved groups of lymph nodes or organs should be irradiated. This often requires several series of x-ray treatments separated by appropriate rest periods.

In patients who have fever, it is of importance that the active focus of the disease be located. In the absence of any peripheral adenopathy, very often the retroperitoneal lymph nodes are diseased. Treatment of the involved area will usually cause the fever to subside within one or two weeks.

TABLE II: SITES OF INITIAL ADENOPATHY

Site	No. Cases	Per-centage
Cervical region	161	74
Axilla	13	6
Mediastinum	12	6
Inguinal nodes	10	5
Retroperitoneal nodes	7	3
Unknown	13	6

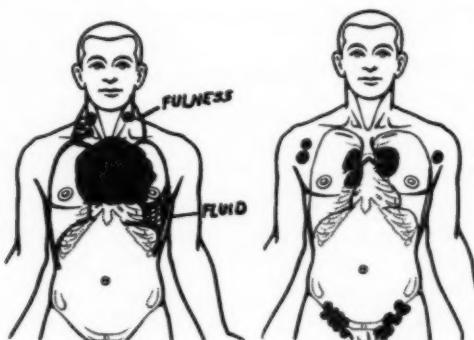


Fig. 2. The above patients, who originally had widespread advanced Hodgkin's disease (Stage III), have survived more than five years.

6. For large, deep-seated tumors in the thorax or abdomen, supervoltage (one million volts) x-rays are decidedly helpful. They reduce the total number of treatments required and can deliver the necessary large tumor doses with a minimal skin reaction.

When there is clinical evidence of organ involvement in addition to multiple lymph-node groups, the prognosis becomes very grave. However, every patient should have the benefit of intensive x-ray therapy. Thirty-two per cent of our Stage III patients lived five years or longer.

To establish the diagnosis, surgery is always employed for the initial biopsy or resection of part of an organ. Even though the surgeon feels that he has removed all of the tumor in an early case, it is advised that the regional tissues and lymphatics be given postoperative x-ray therapy.

If the percentage of five- and ten-year survivals in this disease is to be increased, all areas of potential tumor involvement, as well as the primary lesion, should be irradiated.

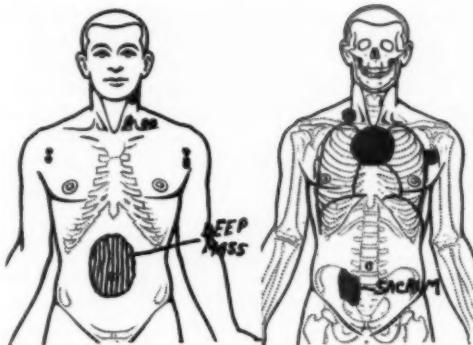


Fig. 3. Two examples of widespread Hodgkin's disease on admission, in patients who subsequently survived more than five years. The patient on the left had severe backache, which disappeared following irradiation. The patient on the right had a destructive lesion of right side of the sacrum.

TABLE III: ORGAN INVOLVEMENT FOUND DURING COURSE OF DISEASE
(Based on clinical, x-ray or postmortem findings)

Organ	No. of Cases	Percentage
Spleen	46	26
Liver	44	25
Lung	30	17
Bone	28	16
Kidney	10	5.5
Spinal cord (extra-dural)	6	4
Skin	4	3
Stomach	3	1.5
Intestine	3	1.5
Pancreas	2	1
Adrenal	2	1
Bladder	1	0.5

Note: As the disease becomes advanced, it is more common to find organ involvement as well as widespread lymph-node involvement.

The most significant achievement in Hodgkin's disease in the past few years is a 51 per cent five-year survival in a group of 113 patients treated predominantly by aggressive irradiation, reported by Peters (10). The five-year survival rate for the 216 cases reported here is lower (37 per cent). The treatment technic in the two series

TABLE IV: CLINICAL STAGE OF DISEASE ON ADMISSION

Stage	No. of Cases	Percentage
I	48	22
II	32	15
III	136	63
Total	216	100

TABLE V: SURVIVAL RATES BASED ON DATE OF ONSET OF DISEASE

Stage	No. of Cases	No. of 5 yr. Survivals	No. of 10 yr. Survivals
I	48 (22%)	29 (60%)	9 (18%)
II	32 (15%)	15 (46%)	7 (21%)
III	136 (63%)	53 (38%)	8 (5%)
Total	216 (100%)	97 (44%)	24 (11%)

Less than 5 year survival, 117 cases.

Lost to follow-up, 2 cases.

Patients living may or may not have active disease.

The patient having the longest survival in this series is living and well, eighteen years after the onset of his disease.

was essentially the same. If anything, our irradiation was more aggressive, in that prophylactic irradiation of uninvolved lymph nodes was more extensively carried out, larger doses were used, and million-volt x-rays were employed for many deep-seated lesions.

TABLE VI: SURVIVAL RATES BASED ON DATE OF FIRST X-RAY TREATMENT

Stage	No. of Cases	No. of 5-yr. Survivals	No. of 10-yr. Survivals
I	48 (22%)	24 (50%)	6 (12%)
II	32 (15%)	14 (43%)	3 (9%)
III	136 (63%)	44 (32%)	6 (4%)
Total	216 (100%)	82 (37%)	15 (6%)

There are several possible explanations for the disparity between Peters' results and those at Walter Reed Army Hospital. Ninety per cent of patients treated in the latter institution were in the twenty- to forty-year age group as compared with 50 per cent of Peters' series. Age may not, however, be a significant prognostic factor.

Women have a better prognosis than men. One-third of Peters' patients were women, as compared with one-tenth in the Walter Reed series. Also, in Peters' series, 40 per cent of the cases were advanced (Stage III), whereas in our series, 63 per cent were advanced (Stage III) cases. These factors account, in part, for the difference in survival rates.

SUMMARY

A review of 216 cases of Hodgkin's disease, from a clinical standpoint, warrants certain conclusions:

1. The disease follows a clinical course typical of a malignant neoplasm. Its first clinical manifestation is usually an enlarged lymph node in the inferior cervical chain. The constancy of this finding suggests that the disease is unicentric in origin.

2. Early diagnosis and aggressive treatment, as in all other malignant neoplasms, is important. The relative increased longevity of patients with Stage I disease bears this out.

3. The diagnosis can be made only by an excision biopsy of a diseased lymph node. Any lymph node, especially in the cervical chain, which remains enlarged for three weeks or longer should be excised for histologic study, except in the presence of a regional inflammatory lesion. In the latter event, biopsy is deferred for later consideration.

TABLE VII: COMPARATIVE SURVIVAL RATES

Author	Place	Date of Publication	No. of Cases in Survey	Percent-age 5 Yr. Survival	Percent-age 10 Yr. Survival
Krumbhaar (7)	University of Pennsylvania	1939		15	6
Slaughter and Craver (12)	Memorial Hospital, N. Y.	1942	265	17.7	3.4
Medinger and Craver (8)	Memorial Hospital, N. Y.	1942	94 (Total body irradiation)	24	
Merner and Stenstrom (9)	Minneapolis, Minn.	1947	185	21	8
Peters (10)	Toronto General Hospital (Canada)	1950	113	51	35
Healy, Amory and Friedman	Walter Reed Army Hospital, Washington, D. C.	1955	216	37	6

4. The treatment of Hodgkin's disease in this series consisted primarily of x-ray irradiation. We feel that this form of therapy is most effective in all except the terminal stages of Hodgkin's disease. Many Stage III patients, so treated, have survived more than five years.

5. Supervoltage (one million volts) radiation has definite advantages in deep-seated tumors.

6. In this series of 216 cases of Hodgkin's disease, the absolute five-year survival rate was 37 per cent.

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SUMARIO

Enfermedad de Hodgkin. Repaso de Doscientos Dieciséis Casos

Un repaso, desde el punto de vista clínico, de 216 casos de enfermedad de Hodgkin justifica ciertas conclusiones:

1. La dolencia muestra una evolución típica de neoplasia maligna. La primera manifestación clínica suele ser la hipertrofia de un ganglio linfático en la cadena cervical inferior. La constancia de este hallazgo sugiere que la enfermedad es unicéntrica en su origen.

2. El diagnóstico temprano y el tratamiento energético son importantes, lo mismo que en todas las demás neoplasias malignas. Confirma esto el aumento relativo en la longevidad de los casos del Período I.

3. No puede hacerse el diagnóstico más que con la excisión biópsica de un ganglio linfático afectado. Excepto cuando existe una lesión inflamatoria regional, debe excindirse para estudio histológico todo

ganglio linfático, sobre todo de la cadena cervical, que permanezca hipertrofiado durante tres semanas o más. De haber lesión inflamatoria, se aplaza la biopsia para consideración subsecuente.

4. En esta serie, el tratamiento de la enfermedad de Hodgkin consistió primordialmente en la irradiación con rayos X. Esta forma de terapéutica parece ser la más eficaz en todos los períodos de la enfermedad, excepto los terminales. Muchos enfermos del período III, tratados en esa forma, han sobrevivido más de cinco años.

5. La irradiación de supervoltaje (un millón de voltios) posee ventajas bien definidas en los tumores profundos.

6. En esta serie de 216 casos, de enfermedad de Hodgkin, el índice absoluto de sobrevivencias de cinco años fué de 37 por ciento.

Aneurysmal Bone Cysts¹

DAVID C. DAHLIN, M.D.,² BYRON E. BESSE, JR., M.D.,³ DAVID G. PUGH, M.D.,⁴ and RALPH K. GHORMLEY, M.D.⁵

IN A COMPREHENSIVE review of the records of more than 2,000 primary bone lesions encountered at operation at the Mayo Clinic in the period 1905-52, 26 aneurysmal bone cysts were found. The lesion first was recognized by Jaffe and Lichtenstein (1), this being one of the many contributions they have made in the field of bone pathology. Our investigation reaffirms their belief that aneurysmal bone cyst is a distinct clinical and pathologic entity.

The specific term "aneurysmal bone cyst" does not appear in the literature until 1942, when Jaffe and Lichtenstein stated for the first time that it was probably a distinct entity and described the findings in 2 cases. In many papers prior to this (2-7), especially those concerning giant-cell tumors and their "variants," more or less complete descriptions of the lesion are encountered under a variety of names. Ewing (8), in 1940, employed the term "aneurysmal giant-cell tumor" for the condition, which he considered to be a benign variant of a giant-cell tumor taking the gross form of a bone aneurysm.

Although the term "aneurysmal bone cyst" was coined in 1942, the literature of the succeeding eight years contains no single comprehensive article on this subject. A number of writers continued to make mention of typical cases, but under a great variety of names (9-13). In 1944, Mayer and Kestler (14) reported 2 cases of "aneurysmal bone cysts of the spine," the diagnosis in these cases being confirmed by Jaffe. By 1950, Lichtenstein (15) and Jaffe (16) each had collected enough cases to write comprehensive articles on the subject. In all important respects these au-

thors are in complete agreement, their only differences being in theories concerning the origin of the lesion and in the reason for choosing its particular name. The clinical, roentgenologic, and pathologic features, as described by them, will be given in detail in the discussion of our cases.

CLINICAL CONSIDERATIONS

The age distribution of our 26 patients was as follows: ages five to nine, 5 cases; ten to fourteen, 6 cases; fifteen to nineteen, 7 cases; twenty to twenty-four, 4 cases; twenty-five to twenty-nine, 2 cases; thirty-five to thirty-nine, 2 cases. The average age was 17.2 years, with a range from five to thirty-seven. Eighteen patients were less than twenty years old. This age distribution is similar to that of the previously reported cases.

Females predominated in our series in a ratio of 16 to 10. Jaffe, in "approximately 20 cases," noted a similar sex distribution. In Lichtenstein's series reported in 1950 (15), there were 7 males and 1 female, but in a recent personal communication he stated that in a later study he found no sex predilection. The apparent predominance of females in our study cannot at this time be said to be statistically significant.

Aneurysmal bone cysts have been reported in the vertebral column, long bones of the extremities, clavicle, ribs, occipital bone, metacarpals, carpal, metatarsals, tarsals, sacrum, innominate bone, and scapula. As yet they have not been reported in the remaining bones of the calvarium, the mandible, or the facial bones. Jaffe stated that in three-quarters of his cases the lesion was located in a vertebra or long bone. In our series, 15 lesions

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were located in the long bones and 5 in the vertebrae. The distribution was as follows:

Tibia.....	6	Sternum.....	1
Fibula.....	5	Rib.....	1
Vertebra.....	5	Occipital bone.....	1
Femur.....	3	Humerus.....	1
Ilium.....	2	Ulna.....	1

The most frequent clinical complaints in the series were pain, swelling, limitation of motion, and tenderness. Twenty-three patients complained of pain, 23 of swelling, 11 of limitation of motion, and 18 of tenderness. The pain and swelling were frequently associated. Usually the pain was not severe but was increased in intensity by exercise. The swelling developed slowly but was progressive. Limitation of motion generally resulted from encroachment on a joint.

The duration of symptoms, as reported by others and as confirmed by our experience, was relatively short. It varied, in our series of cases, from three weeks to three years, with an average of approximately six months.

There was a history of local trauma in some of the cases reported elsewhere, as well as in 12 of our series. Trauma had occurred usually from a few days to one month before the onset of symptoms. In all probability, the injury merely called attention to the lesion by causing a local exacerbation of symptoms.

Patients with vertebral lesions usually had pain and stiffness of the segment of the spinal column in proximity to the involved vertebra. In those cases in which the swelling had progressed to a great extent, there had been encroachment on the spinal cord, with neurologic signs and symptoms. In one case in which the cervical portion of the spinal column was involved, stiffness of the neck, with tilting of the head to one side, was noted long before swelling was evident.

The results of treatment in this series indicate the benign nature of aneurysmal bone cysts. Twenty-four of these patients were traced for periods of time varying from one year (the most recent case) to



Fig. 1. Involvement of the proximal part of the shaft of the right tibia by a well delineated radiolucent lesion which has slightly expanded the cortex. The epiphyseal plate is intact.

thirty-five years, and 19 have been followed for more than five years. Sixteen were treated by curettage with or without supplementary irradiation, with only 1 recurrence. Five lesions could be completely excised, and in all these cases cure was obtained. Amputation, performed because of the size of the cyst in 1 case and after an erroneous diagnosis of a malignant lesion in 2 cases, was curative.

ROENTGENOLOGIC FINDINGS

The roentgenologic manifestations varied. In some cases the lesion seemed to have a rather characteristic appearance, whereas in others it was quite atypical. In 17 of our cases the picture was distinctive, consisting in a well circumscribed rarefied area, usually occupying an eccentric position in the bone, which showed either fine or coarse trabeculae, or both. The trabeculae appeared to be more coarse and more numerous toward the edges of the lesion, producing a characteristic soap-bubble or honeycombed appearance. The cortex bulged eccentrically or was absent at the periphery of the affected segment of bone; frequently only irregular remnants remained (Figs. 1-4). Small bones, such as the fibula or a rib, were often found to bulge symmetrically in a fusiform fashion (Fig.



Fig. 2. Characteristic appearance of an aneurysmal bone cyst in the lower part of the shaft of the right femur. There is extension of the lesion into the medial condyle. Note the trabeculated appearance and well defined peripheral outline in the lateral view.



Fig. 3. Aneurysmal bone cyst in the left ilium. Typical example with blown-out appearance of the cortex, thin outer shell of bone, interior radiolucency, and coarse to fine trabeculae.

5). Without exception, in the more typical cases in which the cortex was disrupted, there was a very thin shell of bone, representing periosteal new bone, around the periphery of the lesion. Although this was generally intact, at times it was interrupted or so thin that its outline was barely discernible. In all instances, however, the ovoid contour of the lesion was still recognizable.

In long bones, the end of the shaft was the site of predilection. If endochondral bone growth was still taking place, the lesion was always on the diaphyseal side of the epiphyseal cartilage and adjacent to it. The tumor did not invade the epiphyseal cartilage and in none of these cases was the epiphysis affected. In older patients, in whom the epiphyseal cartilage was no longer present, the epiphyseal portion of the bone was affected but, with a single exception, it could be seen that the articular cartilage was intact and the joint



space preserved. In 1 case the lesion was of tremendous size, encroaching upon the joint.

The lesions varied in size. Although others have stated that the larger cysts occur in the long bones and the smaller ones in the vertebrae, our series indicates that the size is apparently in direct proportion to the duration of the lesion. The fact that the swelling is of a progressive nature supports this assumption.

In some cases in which the long bones were involved, roentgenologic findings were atypical. In 3 upper tibial and 1 lower femoral lesions there was absence of the characteristic eccentric soap-bubble bulging of the cortex and no trabeculae could be seen. In these cases the lesion was de-

Fig. 4. Aneurysmal bone cyst in the upper part of the shaft of the right humerus which has involved the entire width of the bone, has expanded the cortex laterally, and has caused slight medial erosion of the cortex. The epiphyseal plate is intact.



Fig. 5. Lesion in the upper part of the shaft of the right fibula. There is a fusiform symmetrical expansion delimited by a thin uninterrupted outer shell of bone with good exhibition of fine and coarse trabeculae.

limited by the cortex but involved more of the width of the bone than in the average case. Three months after biopsy, the lesion in 1 of these cases showed a more typical appearance. A fourth tibial lesion showed some of the characteristic findings but was of such size as to cause a fusiform expansion of the entire width of the bone.

In the spinal column, only a part of a vertebral body was involved, with extension of the lesion to the pedicle, lamina, and transverse process. Trabeculae in the bulging region were more sparse than in the long bones. The thin outline of periosteal new bone was readily apparent, and the roentgenologic diagnosis could be made with considerable assurance (Figs. 6 and 7). Occasionally there was infringement on adjacent vertebrae or other bones due to the progressive enlargement; this was of an erosive nature, however, and was not due to actual invasion of the other bones. Lesions which involved T-10 and T-12 displaced the intact rib laterally on the involved side. The roentgenograms of a sacral lesion were of poor quality and obscured by barium. However, there was absence of the right half of the sacrum at the level of S-3, with extension of the process into the body of S-2; also there was eccentric expansion with the remnants of a thin shell of bone evident laterally. Roentgenologically it was impossible to distinguish the lesion from a malignant process.

It is perhaps of interest to consider the original roentgenologic diagnosis in 26 cases, although all but 2 of these were made before the true nature of the lesion was recognized. The diagnoses varied from benign simple cyst to osteogenic sarcoma (Table I).

We may summarize by noting that the aneurysmal bone cyst has a rather typical roentgenologic appearance in most instances. In about 16 of our cases a diagnosis could have been made preoperatively with reasonable certainty. The pertinent findings include a circumscribed area of rarefaction, a soap-bubble or honeycombed appearance of the interior of the lesion, eccentric bulging of the cortex, which is

TABLE I: ANEURYSMAL BONE CYSTS: ORIGINAL ROENTGEN DIAGNOSES

Roentgenologic Diagnosis	Cases
Giant-cell tumor	9
Cyst-like tumor	3
Malignant bone tumor	2
Osteogenic sarcoma	2
Bone cyst	2
Hemangioma	1
Osteochondroma	1
Ewing's tumor	1
Destructive tumor	1
Epidermoid tumor	1
Fibrous dysplasia	1
Aneurysmal bone cyst	1
No roentgen examination	1

usually disrupted, a peripheral, delimiting, thin shell of periosteal new bone, and, in young patients, a location in the diaphysis adjacent to the epiphyseal cartilage.

PATHOLOGIC ASPECTS

The entire gross specimen preserved in formalin and the microscopic slides were available for study in all of these cases. Without such specimens verification of the lesion would have been impossible in several instances.

The gross and microscopic pathologic picture was typical in all cases. In many instances the surgeon commented on the bleeding when he delivered the specimen. These comments varied from "welling of blood when the cortex was removed" to "exudation of blood from the sinuses in and about the cortex." The significant fact is that the surgeon usually had some difficulty with control of hemorrhage.

The gross specimen was ordinarily the product of curettage, and therefore, in pieces. It usually contained many septa separating blood-filled channels measuring up to 1 or 2 cm. in diameter. The more or less fibrous septa were brown to red, and many contained a small amount of calcification. The specimen obtained by curettage was frequently collapsed, but the larger specimens had a sponge-like feeling on compression. One or several fragments of subperiosteal bone of eggshell thickness were usually present. Occasionally, bits of solid tissue were found clinging to the wall of the lesion.

We had the opportunity of studying several intact gross specimens, including a

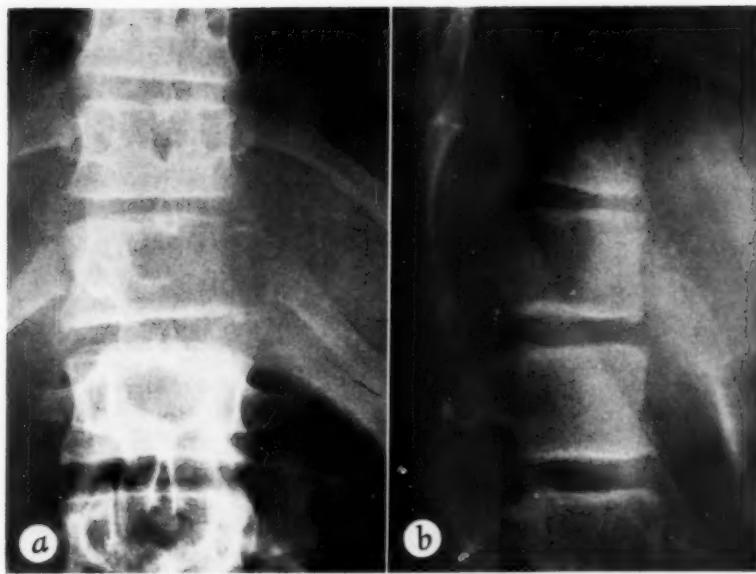


Fig. 6. Aneurysmal bone cyst in the right half of the body of T-12, with lateral ballooning of the vertebral body and lateral displacement of the twelfth left rib. Note the area of rarefaction in the posterior portion of the vertebral body in the lateral view.

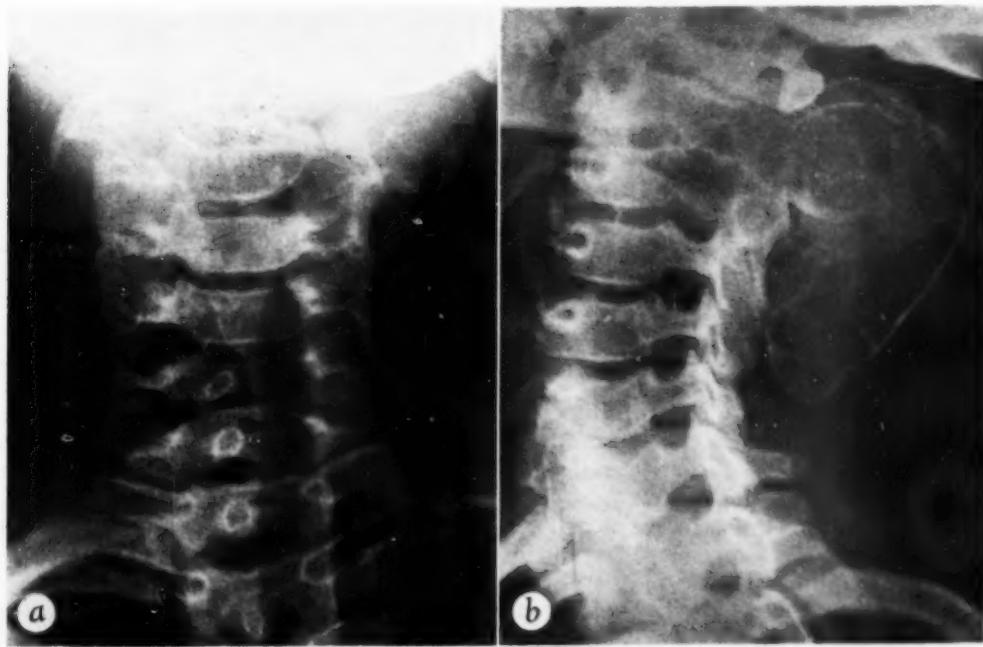


Fig. 7. Involvement of the spine, neural arch, and part of the body of C-2. Note the thin shell of uninterrupted outer bone, the radiolucency of the interior, and the fine and coarse trabeculae.

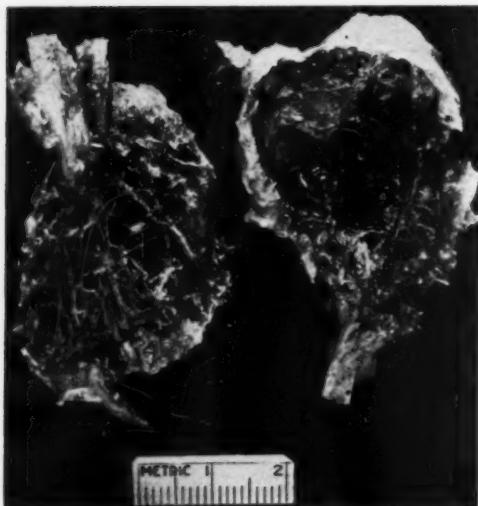


Fig. 8. Cross section through a typical gross specimen obtained by resection of the upper part of the fibula. It shows the characteristic cavernous spaces separated by fibrous-tissue septa.

rib, the upper ends of 3 fibulae (Fig. 8), the lower end of 1 fibula, 1 tibia, 1 femur, and 1 ulna, the 2 last-mentioned following amputation because of an erroneous diagnosis of malignant disease. These entire gross specimens usually showed central cavities up to several centimeters in diameter. The septa became more numerous and the blood channels smaller near the periphery of the lesion. The septa themselves contained minute, grossly visible channels. The cortex was bulged and greatly thinned. Delimiting the lesion peripherally was an eggshell-thick layer of bone which was either subperiosteal new bone or attenuated cortex.

In a large bone, the site of involvement often included only a portion of the normal width of the bone. In a flat bone there was sometimes a fusiform symmetrical dilatation. Occasionally areas of firm, brown, solid tissue were seen, and it was apparently from these areas that the earlier diagnoses of giant-cell tumor had been made. If sections are cut through the solid tissue and not through the honeycombed areas, one may mistake the lesion for an "atypical" giant-cell tumor. However, when the gross and microscopic appearances of the other

areas are considered, that diagnosis should not be entertained. The microscopic sections in our files had often been taken from the solid areas, making it necessary many times that appropriate new sections be taken from the gross specimens in order to demonstrate the typical features of aneurysmal bone cyst.

The microscopic picture (Fig. 9) was as typical as the gross. The main components of the picture were the innumerable cavernous vascular spaces, the supporting connective-tissue septa, the variable numbers of multinuclear cells (which are not essential to the diagnosis), the osteoid or "fiber" bone in the connective tissue, and the layer of periosteal new bone. The sponge work of engorged blood-filled spaces of this type is observed in no other lesion. The channels were rather closely approximated in some places and separated by wider bands of tissue in others. The vascular spaces were frequently not lined by endothelium and were bordered by connective tissue containing no elastic or muscular coat. The blood in the vascular spaces was free and showed no evidence of clot formation (Fig. 9d), indicating that the communication between the spaces was free and that the blood was not stagnant.

The connective-tissue septa were ordinarily fibrous and contained thin strands of "fiber" bone (Fig. 9c and d), the latter being a distinctive feature of the disease. This osteoid was laid down in regular thin strips of varying lengths in the connective tissue and was sometimes partially calcified. The osteoid also was found dispersed through the connective tissue in patches of varying size. At times the connective tissue contained extravasated erythrocytes or showed evidence of organizing hemorrhage. Infrequently, phagocytes that contained hemosiderin were seen in the connective tissue.

Benign multinuclear cells (Fig. 9a) were present in all of the lesions in lesser or greater numbers. These cells were found in greatest number in the fibrous connective tissue, but they also occasionally lay

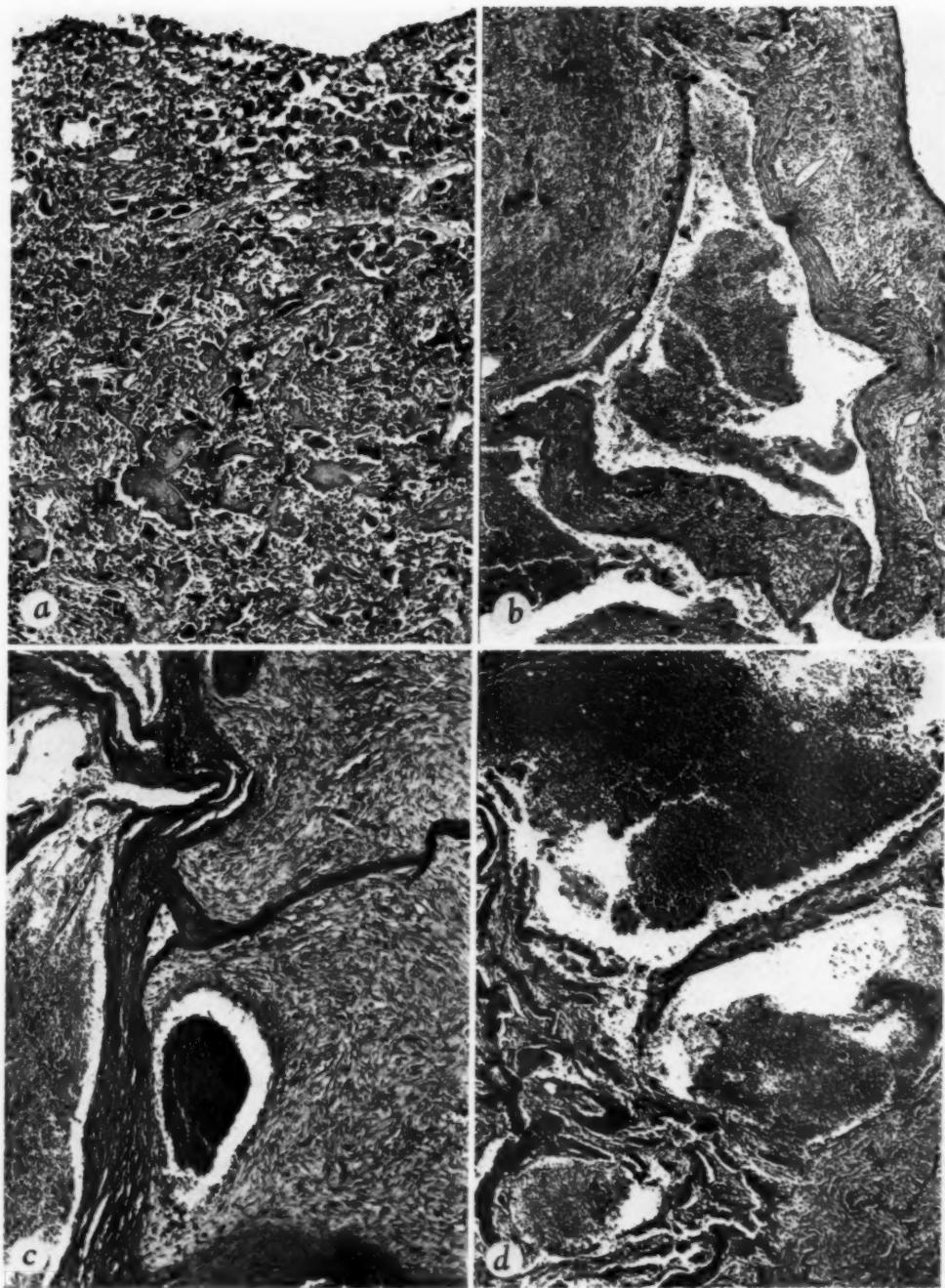


Fig. 9. *a*. Section through a more solid part of an aneurysmal bone cyst. There are a large number of giant cells and plaques of osteoid. Hematoxylin and eosin. $\times 80$. *b*. A complete vascular cavernous space showing the lack of definite lining endothelium. Giant cells and filaments of osteoid can be seen in the fibrous-tissue septa. Hematoxylin and eosin. $\times 55$. *c*. Section showing a fibrous zone separated from blood space at the left edge by a band of osteoid. Hematoxylin and eosin. $\times 65$. *d*. Large pools of unclotted blood with erythrocytes lying free in the cavernous spaces. Note the thin filaments of osteoid tissue. Hematoxylin and eosin. $\times 50$.

loose in the vascular spaces or adjacent to pools of erythrocytes. The great majority of the giant cells appeared to be small and to have small and relatively few nuclei. Other solid areas were less cellular (Fig. 9c) and could have been confused with fibrous dysplasia of bone.

The varied histologic patterns observed in different portions of these aneurysmal cysts are emphasized by the tabulation of original pathologic diagnoses in the 26 cases (Table II).

TABLE II: ANEURYSMAL BONE CYSTS: ORIGINAL PATHOLOGIC DIAGNOSES

<i>Pathologic Diagnosis</i>	<i>Cases</i>
Benign giant-cell tumor	11
Hemorrhagic bone cyst with foreign-body giant cells and inflammation	5
Malignant foreign-body giant-cell tumor	2
Osteitis fibrosa cystica	2
Inflammation with new bone formation	1
Fibro-osteoma	1
Osteoma with foreign-body giant cells	1
Fibrous dysplasia	1
Aneurysmal bone cyst	2

In summary, the various-sized engorged vascular spaces whose walls lack most of the features of normal blood vessels, the connective-tissue septa often containing thin strips of osteoid (fiber bone), and the pools of unclotted blood in the vascular spaces, are diagnostic of aneurysmal bone cyst.

DIFFERENTIAL DIAGNOSIS

The lesions which may bear a certain resemblance to aneurysmal bone cysts, from the standpoint of the roentgenologist and the pathologist, include benign giant-cell tumor, hemangioma, fibrous dysplasia, and simple bone cyst.

Benign giant-cell tumors should be differentiated by roentgenologic means in most instances. Giant-cell tumors usually occur in the long bones, where they almost invariably arise in the epiphysis. In our series of approximately 100 benign giant-cell tumors, none have occurred in the vertebrae except for the sacrum. They are relatively rare in persons less than twenty years of age. They have a marked tendency to recur, and in about 10 per cent of cases they eventuate in metastasizing malignant growths. The two lesions can

be distinguished with complete assurance only by pathologic examination. Microscopically, giant-cell tumors have a homogeneous cellular stroma with numerous multinuclear cells and lack the characteristic cavernous blood spaces of aneurysmal bone cysts.

Hemangioma may be distinguished roentgenologically from aneurysmal bone cyst in the vertebrae in that the former shows characteristic vertical striations on the roentgenogram. The vertebral body alone is affected in most cases, and the lesion may involve one, two, or three vertebral bodies. Aneurysmal bone cysts do not show vertical striation. They usually occur in the vertebral body or neural arch, involve only a portion of the vertebra, and never more than one vertebra except by pressure erosion. They may erode contiguous structures, while hemangiomas do not. Hemangiomas, of course, lack the histologic features so characteristic of aneurysmal bone cysts.

Fibrous dysplasia of bone may be differentiated from an aneurysmal bone cyst by the absence of cystic spaces filled with free blood. In rare instances, the roentgenologic appearance may be such as to defy differentiation, but in most cases the two lesions are distinguished with ease.

The roentgenologic appearance of a unicameral bone cyst is usually characteristic, but it arises in the end of the diaphysis adjacent to the epiphyseal cartilage and therefore in children it resembles the aneurysmal bone cyst to a certain extent. These simple cysts develop in childhood or adolescence and are usually found before the epiphyses have united. They occur in the metaphyseal portion of the shaft, causing fusiform widening of the affected segment. The margins are usually sharper than those of an aneurysmal bone cyst. The overlying cortex is usually thin but always intact unless there has been a pathologic fracture. On pathologic examination it is observed that simple unicameral bone cysts do not contain blood unless as the result of fracture or previous treatment. In addition, these lesions ordinarily lack the

prominent septa and other features of aneurysmal bone cysts. In rare cases the differential diagnosis may be quite difficult.

The roentgenologic diagnosis of atypical aneurysmal bone cysts offers great difficulty. Processes other than those already considered may enter into the differential diagnosis. These include osteogenic sarcoma, metastatic carcinoma, fibroma, and chondroma, all of which are readily recognized on gross and microscopic examination.

SUMMARY AND CONCLUSIONS

Aneurysmal bone cyst is a distinct benign pathologic entity. In approximately two-thirds of the cases it exhibits a characteristic roentgenographic picture. Curettage is the treatment of choice, and at the time of the operation the gross features of the cyst should make its recognition possible. The macroscopic and microscopic features establish the correct diagnosis.

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SUMARIO

Quistes Oseos Aneurismáticos

El quiste óseo aneurismático constituye una entidad patológica benigna bien definida. Aproximadamente en dos terceras partes de los casos, manifiesta un típico cuadro radiográfico. Los hallazgos pertinentes comprenden una zona circunscrita de rarefacción; aspecto de burbuja de jabón o de panal del interior de la lesión; abultamiento excéntrico de la corteza, que suele estar desgarrada; cápsula delgada, delimitante, periférica de nuevo hueso perióstico; y, en los enfermos jóvenes, localización en la diáfisis adyacente al cartílago epifisario. El raspado es el trata-

miento de elección y, en el momento de la operación, las características de la lesión deben permitir su reconocimiento.

Las características macro y microscópicas de la lesión establecen el diagnóstico acertado. Las últimas comprenden espacios vasculares congestionados de varios tamaños, cuyas paredes carecen de la mayor parte de las características de los vasos sanguíneos normales; tabiques de tejido conjuntivo, que contienen a menudo delgadas tiras de osteoide (hueso fibroso); y charcos de sangre incoagulada en los espacios vasculares.

The Use of Carbonated Beverages in Pediatric Excretory Urography¹

JOHN W. HOPE, M.D., and FRANCISCO CAMPOY, M.D.

INTRAVENOUS urography is an important diagnostic procedure in pediatric radiology, but there are two factors which make this examination a difficult problem: first, the large amount of gas and feces present in the gastrointestinal tract; sec-

the examination or concluding merely that it showed no gross abnormalities but that fine detail of the pelvo-calyceal collecting system could not be visualized. Pediatricians in the Philadelphia area often hesitated to order an intravenous urogram be-

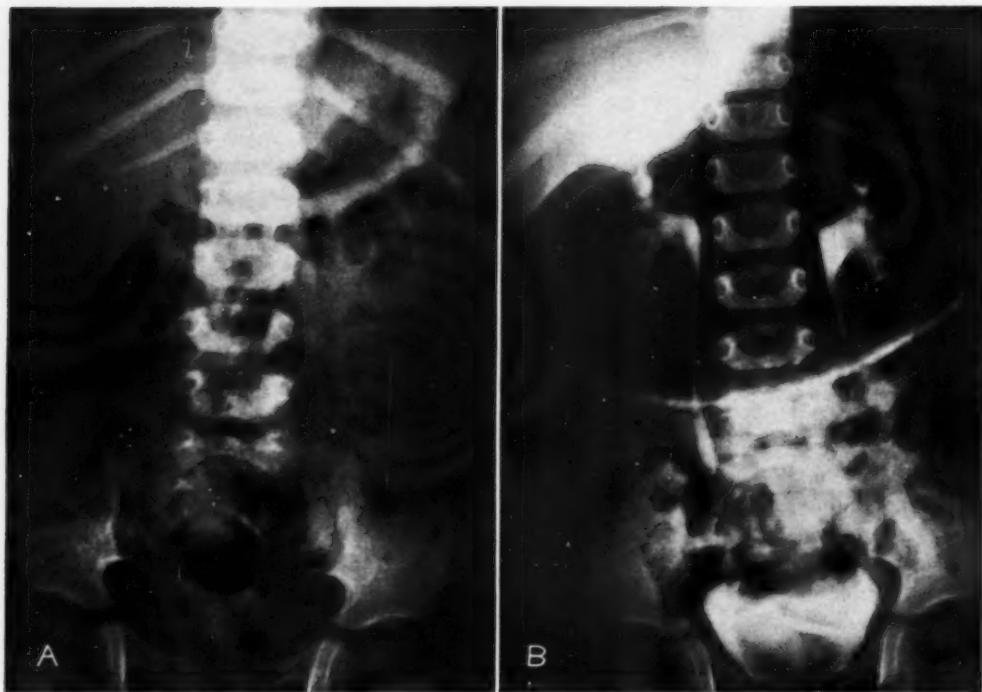


Fig. 1. Case of a two-year-old boy with a fever of unknown origin.

A. Preliminary film showing the usual gas and fecal shadows.

B. Film taken fifteen minutes after the injection of 25 c.c. of 70 per cent Urokon followed by the ingestion of 4 to 5 ounces of Pepsi Cola. Both pelvo-calyceal collecting systems are well demonstrated, as are the ureters. Note the very dense pelvo-calyceal collecting systems. This degree of visualization is almost routine with 70 per cent Urokon.

ond, the low specific gravity of the urine in infants, preventing concentration of the contrast medium and resulting in poor visualization of the pelvo-calyceal collecting system. Before the advent of the method to be described, we were often guilty either of calling for a repetition of

cause so frequently no diagnosis could be made.

Cathartics will usually clean out the fecal material from babies and children, but the amount of gas generally increases, thereby aggravating the problem. Proping the child in the upright position for

¹ From the Department of Radiology, the Children's Hospital of Philadelphia, Philadelphia, Penna. Accepted for publication in October 1953.

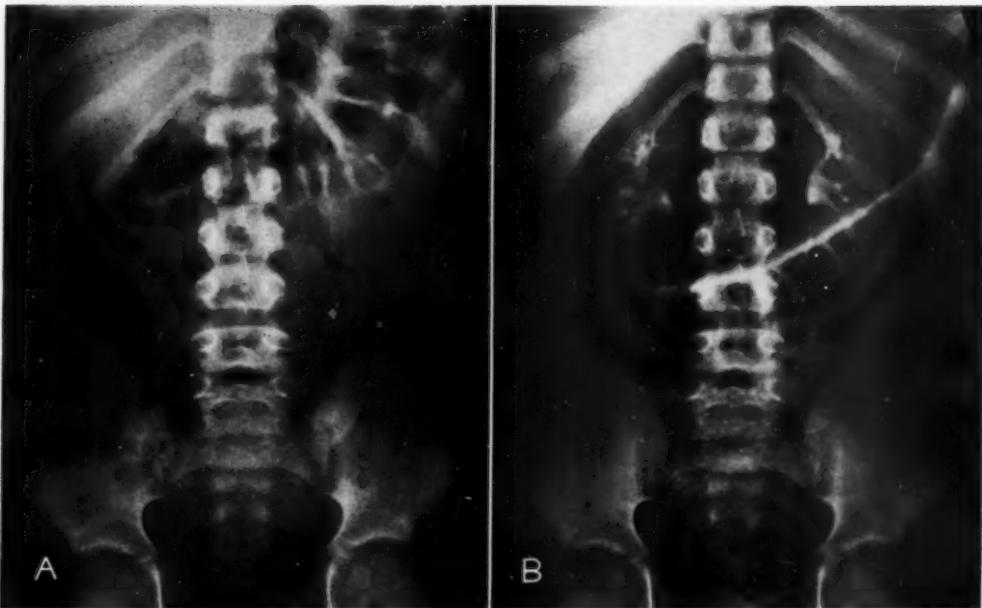


Fig. 2. Case of a six-year-old boy with vague abdominal pain and occasional pain on voiding.

A. Preliminary film showing considerable gas and confusing haustral markings.

B. A film taken five minutes after the injection of 20 c.c. of 35 per cent Diodrast intravenously and ingestion of 10 ounces of Pepsi Cola shows complete detail of both pelvo-calyceal collecting systems.

several hours before the study is satisfactory in theory, but by the time the venipuncture has been performed and the contrast medium injected, the bowel is full of gas.

Many clinics make no attempt at preparation of these young subjects but simply take preliminary films. If the abdomen is too full of confusing shadows, the patient returns on the following day for another preliminary film. Because of the high cost of hospitalization, it is imperative that diagnostic studies be performed as rapidly as possible. To keep a child several days in the hospital awaiting the disappearance of gas and feces is both uneconomical and undesirable.

After a trial of the common methods of preparation for some six months, to no avail, we also came to the conclusion that it was better to omit all preparation. It was at this time that our attention was drawn to an article by Berg and Allen (1) describing the use of carbonated beverages as an aid in pediatric excretory urography.

Though somewhat skeptical of this method, we decided to give it a trial. Because we personally liked Pepsi Cola, this was the first carbonated beverage to be employed. From the very first time this carbon dioxide-producing beverage was used, we were satisfied with the diagnostic quality of our intravenous urograms (Figs. 1 and 2). It has also been employed successfully for visualization of the spleen by contrast with the gas-distended stomach in cases in which a differential diagnosis between an abdominal mass and a low-lying spleen has to be made.

A review of 200 urograms obtained with the aid of Pepsi Cola in infants and children of all ages has revealed only 10 failures, or 5 per cent—cases, that is, in which we had to revert to the old phrase: "There are no gross anatomical abnormalities, but the fine detail of the pelvo-calyceal system cannot be seen because of the overlying gas and fecal shadows."

We do not claim that this method of study is original. At least two papers

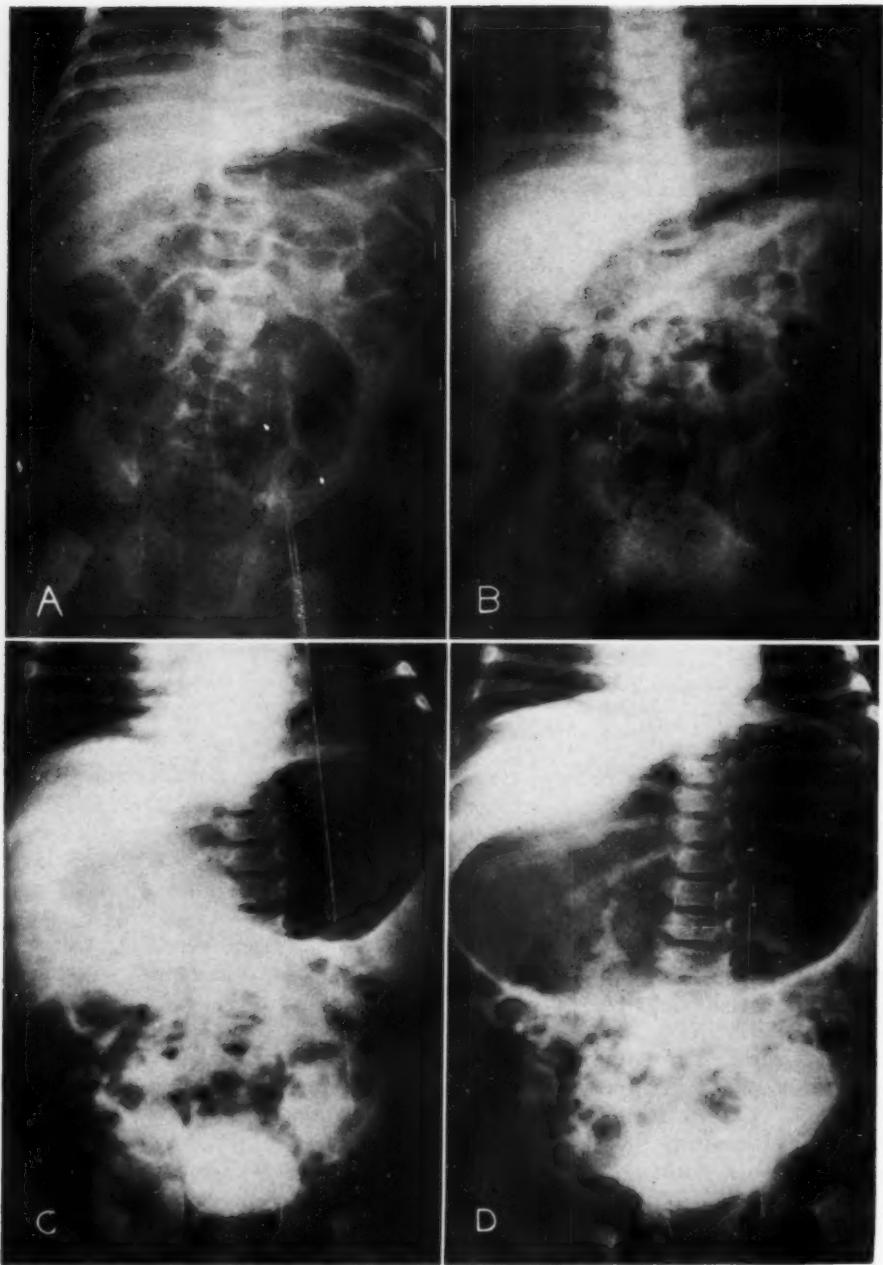


Fig. 3. Case of an eight-week-old male who was found to have pus in the urine.

- A. Preliminary film showing the normal gas and fecal shadows.
- B. Film taken five minutes after the injection of 20 c.c. of 35 per cent Diodrast without employing Pepsi Cola. It is almost impossible to see the kidneys.
- C. Film taken fifteen minutes after the injection and following administration of 40 c.c. of Pepsi Cola. Only the upper pole of left kidney is seen.
- D. Film taken twenty-five minutes after the injection and following the administration of another 30 c.c. of Pepsi Cola. Both kidneys are well visualized.

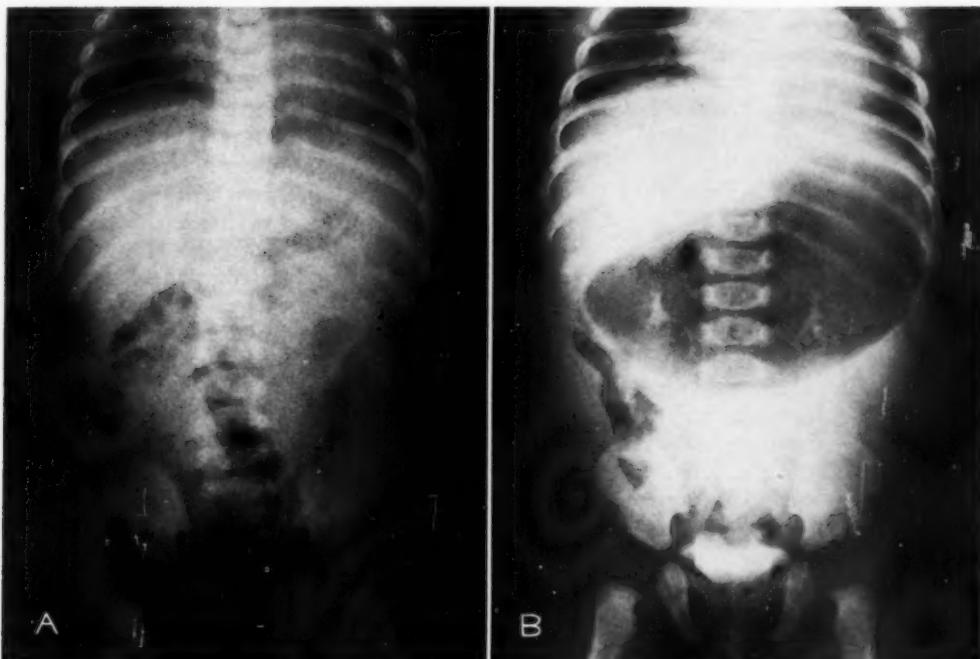


Fig. 4. Case of a four-week-old female with a suspected urinary tract infection.

A. Preliminary film showing a moderate amount of air in both the small and large bowel.
B. A film taken fifteen minutes after the injection of 20 c.c. of 35 per cent Diodrast. Approximately 60 c.c. of Pepsi Cola were taken by mouth following the injection. Both pelvo-calyceal collecting systems are well seen through the gas-distended stomach.

dealing with it have appeared, both in the urologic literature: that by Berg and Allen, mentioned above and one by Matthei (2). We believe, however, that we have developed several improvements which contribute to the success of the method.

In the case of infants, our technic for carrying out excretory urography calls for dehydration for only one feeding; older children receive nothing by mouth for approximately ten to twelve hours before the examination. A preliminary film is taken, and the contrast medium is administered intravenously. Regardless of the age of the child, he is now screaming and thirsty. The infants are immediately offered a bottle and the older children a glass of Pepsi Cola. Almost without exception the screaming subsides at once, and the older children become more cooperative. It is at this point that the doctor or technician must insist that the infant receive 2 ounces and the older child 6 to 12 ounces before the

five-minute film is taken. Occasionally this is not possible and the five-minute exposure has to be made, after which the patient is given the rest of the carbonated beverage. A ten- and a fifteen-minute film are then taken, developed immediately, and viewed by the doctor even before they are completely fixed. If there is not sufficient gaseous distention of the stomach to push away all the overlying shadows from the kidneys, more Pepsi Cola is given and another film is obtained as soon as possible. This will usually be twenty-five minutes from the time of injection (Fig. 3). A long delay at this point will often result in failure, because in normal babies and young children most of the contrast medium will already be in the bladder at the end of thirty minutes.

The success of this method depends upon preventing it from becoming a mere routine. If the radiologist is disinclined to give this study his personal attention and

turns it over to the technicians to be pushed through routinely, it will result in failure. If, on the other hand, each study receives the personal attention of the radiologist, a high percentage of successful results will be obtained.

The most common reason for failure in our experience has been the ingestion of an insufficient quantity of Pepsi Cola or vomiting of the beverage before the films are exposed. If, as suggested above, the doctor sees the first three films as soon as they are developed, immediately gives more of the beverage, and orders a twenty-five- or thirty-minute film, a successful study usually results. With oblique films, the gas-filled stomach can occasionally be positioned over the kidneys. If vomiting ensues, one can wait a minute or two before giving more of the beverage.

Babies almost never present a problem, since they will take anything from a bottle with a comfortable nipple (Fig. 4). We have given the beverage to an infant three days old and he apparently liked it. Thus far, none of our pediatricians have found any reason to object to the use of the beverage in children of this age.

By experience, eight years of age has been established as the limit for the use of this method. Beyond that age, the gas-filled stomach, even after the ingestion of 12 ounces of Pepsi Cola, will usually be above the lower half of the left kidney, and as a rule the antrum and pylorus will overlie the right pelvo-calyceal collecting system. Even the use of the Trendelenburg position does not help at this age. However, children of eight or nine years can be prepared successfully by the methods used for adults.

"Burping" is a problem which is met occasionally, but not as frequently as we had expected. Here again either the technician or the doctor must be present to give individual attention to the patient. If the

sound issues forth before the ten- or fifteen-minute films are taken, more Pepsi Cola must be given.

Another question arose when we began this method of study. It seemed rather illogical to dehydrate a patient beforehand, only to have him drink during the study. This matter was discussed with several urologists and physiologists, and it was their opinion that the amount of fluid which would be absorbed in the first fifteen to thirty minutes would be insufficient to influence the concentration of the contrast medium. Use of the method has proved this view to be correct.

When we began the use of carbonated beverages, we also expected that gas passing into the small bowel would present a problem. Fortunately, however, no gas passes through the pylorus in the first fifteen minutes, and relatively little in the first thirty minutes.

In the course of our experiments, we have tried most of the carbonated beverages, but we prefer Pepsi Cola. Many children do not like ginger ale, and we do not think the latter gives off as much carbon dioxide as Pepsi Cola. Coca Cola works well, but a bottle of Coca Cola contains less fluid than one of Pepsi Cola.

SUMMARY

A method of employing carbonated beverages to improve pediatric excretory urography has been described. The use of this method has greatly increased the diagnostic quality of this important examination in infants and children.

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SUMARIO

El Empleo de Bebidas Gaseosas como Ayuda en la Urografía Excretoria en Pediatría

Dos factores intervienen en las dificultades que acompañan a la urografía excretoria en los lactantes y niños pequeños: (1) la gran cantidad de gas y heces en el tubo gastrointestinal y (2) el bajo peso específico de la orina en los lactantes, que impide la concentración del medio de contraste y ocasiona mala visualización del sistema colector pelvi-cálico.

Se ha observado que la administración de una bebida gaseosa (Pepsi Cola) mejora considerablemente los resultados de dicho examen en los niños hasta la edad de ocho años. Despues de la deshidratación preparatoria del enfermito, se toma una radiografía preliminar, a continuación de la

cual se inyecta intravenosamente el medio de contraste. Inmediatamente después, se suministra la Pepsi Cola, en una botella (60 c.c.) a los lactantes y en un vaso (180 a 360 c.c.) a los niños mayores. Se toman entonces radiografías a los cinco, diez y quince minutos, que estudia en el acto el médico. Si para entonces la distensión gaseosa del estómago no basta para alejar de los riñones las sombras sobreyacentes, se administra más Pepsi Cola y se toma otra radiografía.

De 200 urogramas obtenidos con este método en lactantes y niños de toda edad, solamente 10 (5 por ciento) no resultaron satisfactorios.



Demonstration of the Pericardial Shadow on the Routine Chest Roentgenogram: A New Roentgen Finding

Preliminary Report¹

VICTOR KREMENS, M.D.

ATTENTION has not previously been drawn in the radiologic literature to a visualization on the routine postero-anterior chest roentgenogram of the pericardial shadow along the left cardiac contour. The silhouette of the pericardium, normal or abnormal, becomes demonstrable in those instances in which there is sufficient deposition of subepicardial fat to afford a linear or curvilinear contrasting shadow of increased radiolucency between the density of the myocardial mass and the adjacent parietal pericardium. It must be understood that the explanation for the roentgen finding herein described is presented on a theoretical basis. Postmortem studies and roentgen-anatomic correlation will be the subject of a future report if results so warrant.

ANATOMICO-PATHOLOGICAL ASPECTS

The pericardium is described as a fibro-serous sac in which the heart and the roots of the great vessels are contained (1). The parietal pericardium consists of a serous membrane composed of a single layer of flattened mesothelial cells resting on loose connective tissue, which connects it to an outer fibrous layer. The visceral pericardium, or epicardium, is lined by a single layer of polygonal cells which may be flat or cuboidal, depending on the state of contraction of the heart. Below this is a layer of connective tissue, the subepicardial layer of areolar tissue, connecting the epicardium to the myocardium and containing blood vessels, nerves, and varying amounts of fat (2). The pericardial cavity is merely a potential space, and in the normal state the serous layers of the visceral and parietal tunics are everywhere in

contact and the adjacent surfaces are moistened by a slight amount of serous fluid.

The mediastinal pleura lies in close apposition to the parietal pericardium and these structures are, in fact, fused above but separate at the level of the left lower pole of the heart. The separated pleural and pericardial layers, along with the diaphragm, invest a space filled with loose connective tissue and a variable amount of fat, a space variously referred to as the apical, or pericardial, or epicardial fat pad (3, 4). This extrapericardial collection of adipose and loose connective tissue so frequently seen on the roentgenogram in the left (and right) cardiophrenic angle is not to be confused with the subepicardial fat layer being described (Figs. 1 and 2).

Gross inspection of the fresh human heart after removal from the pericardial sac, at the postmortem table, readily reveals the yellowish fatty tissues of the subepicardial layer upon its surface as seen through the closely applied and transparent overlying mesothelial cells. The amount of adipose tissue seen on the gross specimen shows considerable variation in different individuals, depending in part upon the general nutritional status preceding demise. It is only in those instances where death has occurred following a chronic wasting illness that this adipose collection is not encountered grossly.

ROENTGEN APPEARANCE

The subepicardial fat layer along the left cardiac contour may be best visualized on the routine postero-anterior chest roentgenogram if usual technical factors of not more than one-tenth of a second exposure

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and a target-film distance of 6 feet are used with a fine focal spot tube.

The fat layer on the myocardial surface (which is of significance mainly in that it permits the adjacent parietal pericardium to be seen) appears as a curvilinear shadow of

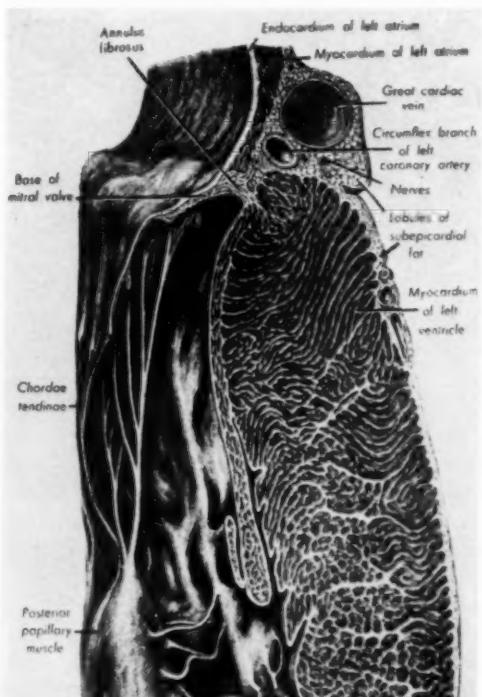


Fig. 1. A semidiagrammatic drawing of the heart in cross section showing the anatomic relationships of the myocardium, subepicardial layer of areolar tissue, and overlying epicardium or visceral pericardium. From Bailey's Textbook of Histology. Baltimore, Williams and Wilkins Co., 12th ed., 1948.

relatively increased radiolucency, varying from a fraction to 1.0 or 2.0 mm. in width and extending for a variable distance along the curved prominence of the left ventricular border. This radiolucent line may also be encountered as a relatively straight linear shadow along the pulmonary artery segment of the left cardiac contour, either alone or in conjunction with the more inferiorly placed curvilinear shadow already described. There is, in fact, due to greater deposition of fat within the normal concavity in the region of the pulmonary artery segment along the left contour, a much

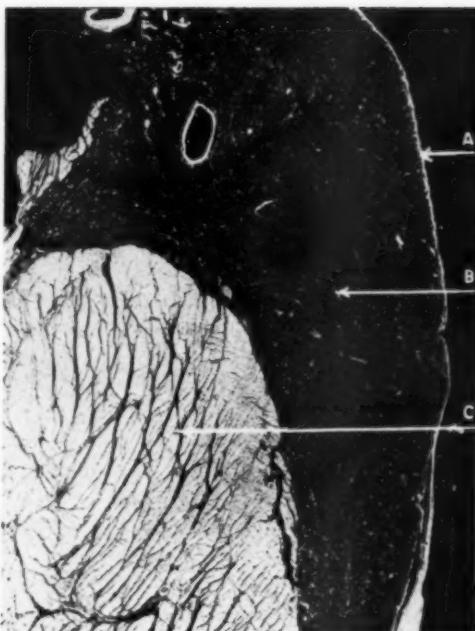


Fig. 2. Photomicrograph of histologic section from left heart border showing relationship of myocardium, subepicardial areolar layer containing much fatty tissue and overlying layer of mesothelial cells comprising the epicardium. A. Epicardium. B. Subepicardial layer of areolar tissue. C. Myocardium.

more frequent visualization of the subepicardial fat layer here than along the left ventricular border. Apart from the basic roentgen-anatomic evaluation of this subepicardial-pericardial shadow pattern in the region of the pulmonary artery segment, however, it is felt that its demonstration is of somewhat less significance and less clinical applicability than that of the similar pattern presented along the lower left myocardial surface. This conclusion is based in part upon the frequently encountered confusing vascular and air-containing bronchial shadows superimposed upon the region of the pulmonary artery segment, i.e., the lung root structures.

The sagittal section of the pericardial (parietal) shadow which is thrown into relief by the subjacent radiolucent subepicardial fat layer is normally represented by a fine linear or curvilinear shadow of increased density approximating the density of the cardiac shadow itself. This shadow

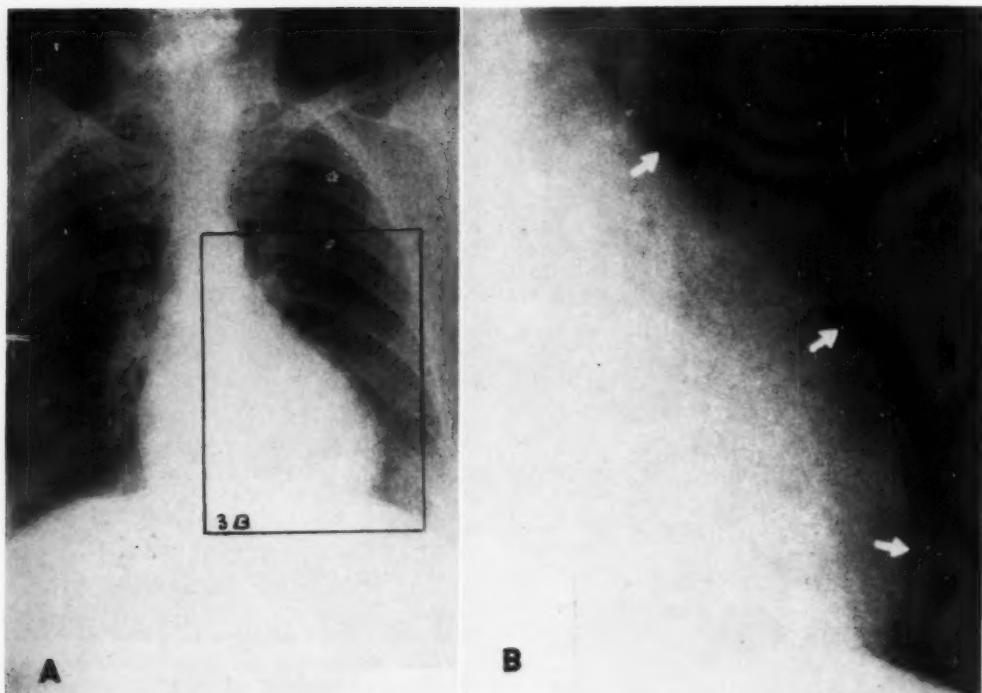


Fig. 3. A. Roentgenogram of chest of a 61-year-old female, demonstrating the normal subepicardial-pericardial shadow pattern along the left heart border. B. Enlarged reproduction of indicated segment in 3A. All of the photographs of roentgenograms reproduced in this paper have been retouched to permit adequate visualization.

varies in width in normal individuals from a fraction to 1 or 2 mm. and closely parallels the subepicardial fat layer. The linear increased density of the pericardium may be differentiated easily from adjacent over-lying vascular markings. Vascular shadows are characteristically tapered in configuration as they course distalward; they disclose frequent branching, and may be followed laterally into the pulmonary parenchyma beyond the cardiac shadow. The finely delineated pericardial shadow is everywhere along its course of constant width and follows with expected anatomic fidelity the gentle curve of the left heart border (Figs. 3-5).

There is no apparent explanation for lack of visualization of a subepicardial fat layer in any of the cardiac contours other than along the left border, in the postero-anterior chest roentgenogram. It may be stated empirically that a somewhat greater

deposition of adipose tissue occurs on the left myocardial surface. Also, the normal prominence of the shadow of the left ventricle, with projection beyond the main bulk of the left lung root vascular shadows, permits optimum visualization in this area. Oblique projections have not facilitated demonstration of this finding.

Use of the Bucky diaphragm in obtaining a roentgen chest exposure will in some instances afford a better delineation of the pericardial shadow, though this is not always the case, and our experience has shown that optimum visualization is usually obtained with properly applied non-Bucky technic.

In those instances where, by virtue of identifying a subepicardial fat layer on the roentgenogram, a thickened pericardial shadow is demonstrated, serial planigraphic exposures of the heart may afford striking confirmatory evidence of the abnormal

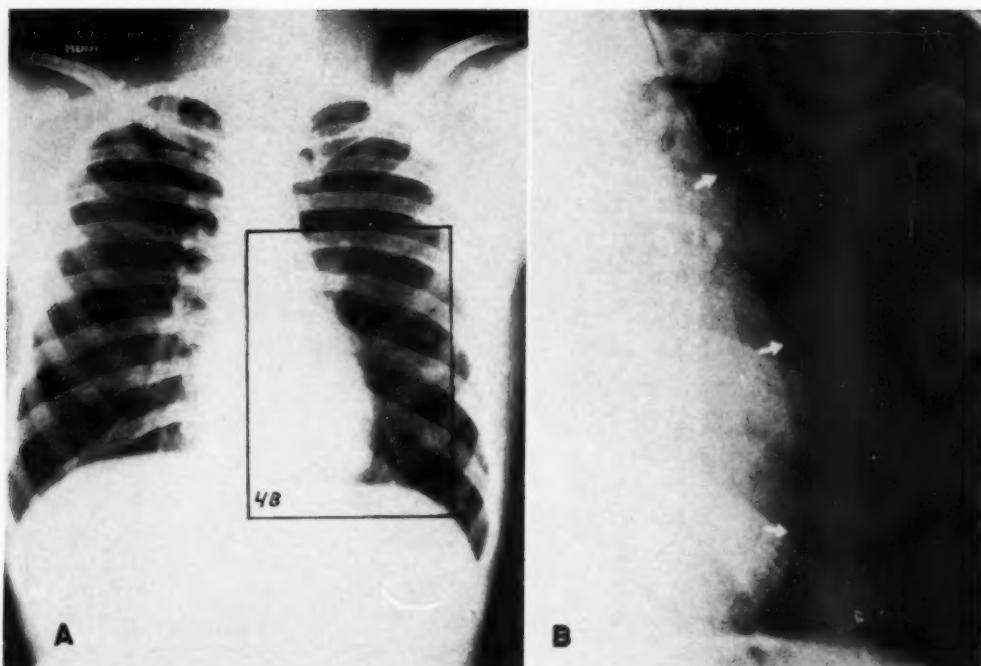


Fig. 4. A. Roentgenogram of chest of a 17-year-old male, demonstrating the normal subepicardial-pericardial shadow pattern. B. Enlarged reproduction of indicated segment in 4A.

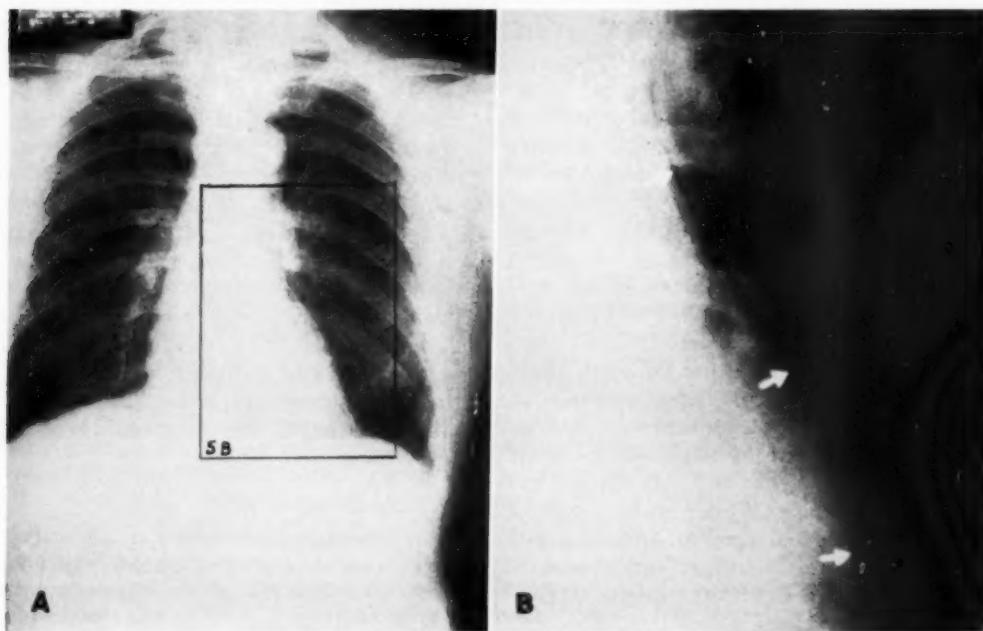


Fig. 5. A. Roentgenogram of chest of a 72-year-old male, demonstrating the normal subepicardial-pericardial shadow pattern. A linear shadow of increased density seen along the right heart border is believed most probably to have been produced by a superimposed pulmonary vascular shadow. B. Enlarged reproduction of indicated segment in 5A.

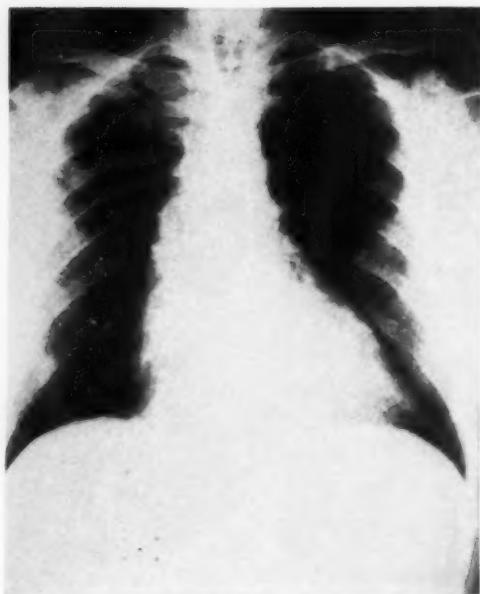


Fig. 6. Routine admission postero-anterior chest roentgenogram of patient J. M. (case presentation) on Aug. 21, 1952, showing cardiac enlargement with a shadow of decreased density 2 cm. medial to the apparent left heart border.

state. The planigraphic exposures are obtained with the patient in the prone position and the central ray of the x-ray beam directed over the estimated position of the left heart border. Levels varying from 2 to 6 cm. from the table top appear to be optimum. The longer exposure time required for planigraphic study (two or two and a half seconds) may result in blurring and, in some instances, in obliteration of the fine shadows in normal persons. With thickening of the pericardium, however, or with a pericardial effusion, these shadows are more gross in nature and, despite the loss of detail produced by cardiac pulsation, there is less likelihood of their obliteration or "erasure". Despite blurring of the left heart border, some degree of relative differential density is maintained in the planigrams. In fact, on a theoretical basis, with such blurring due to cardiac pulsation we may obtain a slight widening or exaggeration of the component shadows of the subepicardial-pericardial shadow pattern.

INCIDENCE

A study of frequency of visualization of the shadow pattern under discussion as it occurs in normal individuals has not as yet been sufficiently extended for presentation at this time. If subsequent findings warrant, this matter will be the subject of a future report. The impression has been obtained that a clear and unequivocal demonstration of the subepicardial-pericardial shadow pattern is probably not obtained in more than 5 per cent of normal individuals. Less clearly defined or less complete demonstration may be encountered in an additional 5 per cent. The incidence of visualization appears so far in our observation to be equally distributed in both sexes.

The age of the individual has been seen to be a significant factor affecting incidence of visualization, in that increasing pulmonary fibrosis and pulmonary vascular congestion in the older age group interfere with optimum demonstration of the subepicardial fat. General degenerative processes as they affect all body tissues undoubtedly play some part in the lower frequency of demonstration in this age group.

Gross estimates of the state of nutrition and body build in the material studied to this point would indicate that a somewhat more frequent and clearer visualization of the pericardial shadow is obtained in well nourished individuals with their more abundant general adipose deposition. It is to be noted, however, that excellent demonstrations have been obtained in many hyposthenic individuals and, indeed, in some instances in which the general state of nutrition has been adjudged as rather poor.

CASE PRESENTATION

The following case history is illustrative of the clinical application of roentgen demonstration of the pericardial shadow in the abnormal state.

J. M., a 61-year-old white male office worker, was admitted to the Northern Division of the Albert Einstein Medical Center on Aug. 15, 1952, complain-

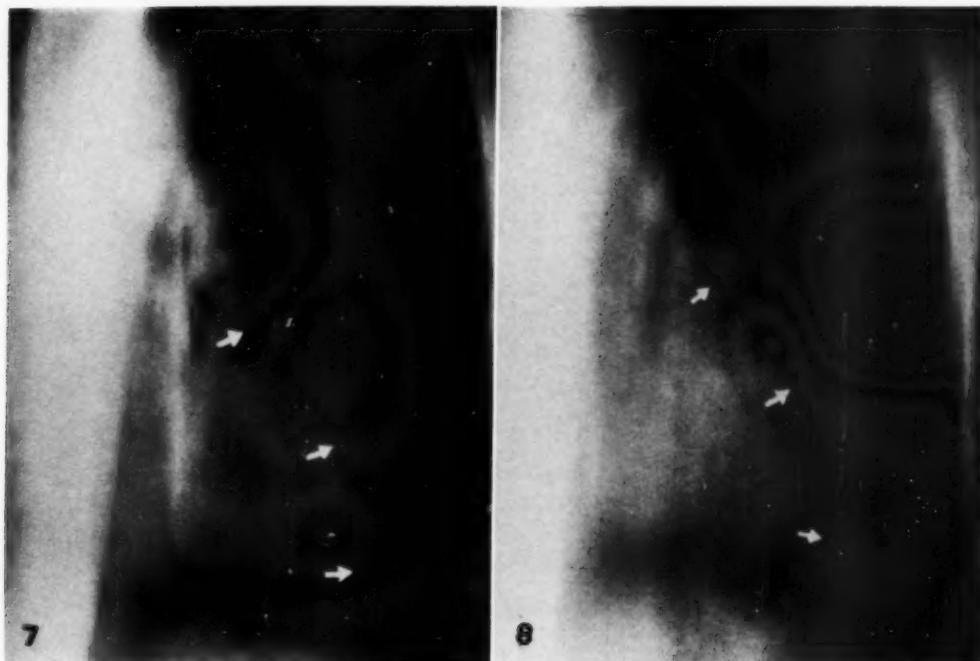


Fig. 7. Planigraphic roentgenogram of heart (J. M.) on Aug. 25, 1952, demonstrating a curvilinear shadow of increased radiolucency 2 cm. within the apparent left heart border. This is interpreted to represent the subepicardial fat layer and to afford visualization of the adjacent thickened pericardium measuring 2 cm. in width. On the basis of roentgenoscopic study it was determined that the abnormal shadow was produced by a thickened fibrinous pericardium rather than by pericardial effusion.

Fig. 8. Planigram of heart (J. M.) on Sept. 22, 1952, again demonstrating the thickened or widened pericardial shadow, now measuring 1.5 cm. in width. The subepicardial fat layer is unchanged in appearance when compared with the previous planigraphic study. The patient at this time had been under treatment for one month.

ing of weakness, left upper chest and neck pain, and fever of six weeks duration. The left chest pain was exaggerated on motion or heavy breathing.

The heart appeared slightly enlarged, and the heart sounds were faint. Pulse rate was 82 per minute. Temperature ranged between 98.5 and 101°. Sedimentation rate (Wintrobe) was 48 mm. in an hour. The leukocyte count was 13,000. Changes indicating anterolateral wall myocardial damage were observed electrocardiographically on the day following admission.

Röntgen study of the chest on Aug. 21 (Fig. 6) showed considerable enlargement of the cardiac shadow. A crescentic curvilinear shadow of increased radiolucency paralleled the left heart border 2 cm. within or medial to the left border of the heart. No abnormal calcification was noted. Planigraphic study of the heart on Aug. 25 (Fig. 7) revealed an essentially normal left ventricular contour with what appeared to be a considerably thickened overlying pericardium or collection of fluid within the pericardial sac.

On the basis of the clinical picture presented, and in view of the roentgen findings, a tentative diagnosis of pericarditis was established. A tuberculin

test was negative with PPD No. 1, and positive with PPD No. 2. Despite failure to make a differential diagnosis between a tuberculous pericarditis and an acute benign pericarditis, therapy with streptomycin and PASA (para-amino salicylic acid) was instituted and this medication was continued for three weeks. At the conclusion of this period the general condition had improved. Precordial pain was no longer present. Heart sounds were more distinctly audible. The sedimentation rate had decreased and the white blood count had returned to normal.

Repeat planigraphic study of the heart on Sept. 22, 1952 (Fig. 8) again demonstrated thickening or widening of the pericardial shadow, but of decreased degree, the shadow at this time appearing approximately one-fourth the size of the original planigraphic image. The pericardial shadow measured 1.5 cm. in width at this time.

The patient was discharged to the care of his family physician, but was readmitted to the hospital one month later (Oct. 27, 1952) because of recurrence of precordial pain associated with exertion. The pulse rate at this time was 80 per minute and the sedimentation rate (Wintrobe) 23 mm. in an hour. Electrocardiographic study revealed some continu-

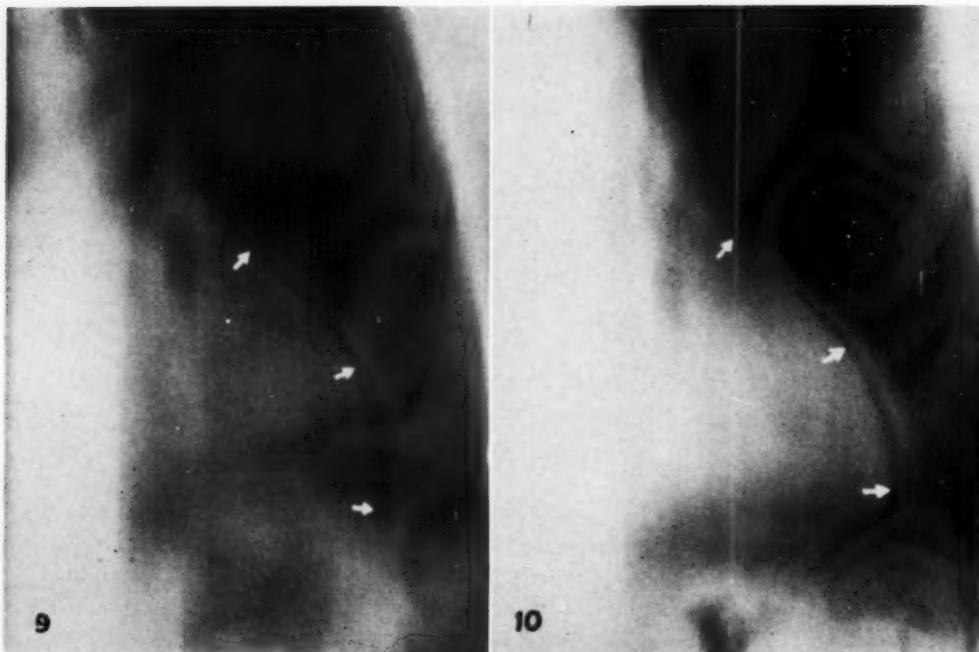


Fig. 9. Planigram of heart (J. M.) on Oct. 28, 1952, again demonstrating a subepicardial-pericardial shadow pattern and showing further decrease in width of the thickened pericardial shadow. The shadow now measures 8 mm. in width at a comparable point.

Fig. 10. Follow-up planigraphic study of the heart (J. M.) on Dec. 24, 1952. The patient is now asymptomatic and has returned to his normal routine. Further decrease in the width of the pericardial shadow has not occurred, a measurement of 8 mm. again being obtained. The subepicardial fat layer remains clearly defined, with no significant obliterative change due to the inflammatory process.

ing but unchanged evidence of myocardial disease (anterior wall). X-ray examination of the chest showed a slight diminution in cardiac size. Planigraphic study of the heart (Fig. 9) again demonstrated pericardial thickening (effusion having been excluded on the basis of the usual roentgen and fluoroscopic observations), but the abnormal pericardial shadow now (Oct. 28) measured 8 mm. in thickness as compared to 2 cm. at the time of original study on Aug. 25 and 1.5 cm. on Sept. 22 following one month of observation and therapy.

The patient was discharged, improved, to his family physician on Nov. 3, 1952.

Follow-up examination on Dec. 24, 1952, found the patient asymptomatic, working and apparently well adjusted to his normal routine. X-ray studies (Fig. 10), including planigraphic sections, showed no further decrease in the width of the abnormal pericardial shadow, which again measured 8 mm. in thickness. Heart size on the routine roentgen examination of the chest appeared essentially normal.

The final discharge diagnosis was pericarditis, etiology undetermined. The response to streptomycin and to PASA therapy, both clinically and as determined roentgenographically, did not permit ex-

clusion of a tuberculous etiology, but the general course of the illness and its lack of gravity suggested a diagnosis of acute benign pericarditis as perhaps more likely.

This patient, following admission to the hospital and prior to the initial roentgen examination, was thought to be suffering from a myocardial infarction. The presence of a pericarditis, though considered among the differential diagnostic possibilities, was not established until the abnormal pericardial shadow was demonstrated on the routine postero-anterior chest roentgenogram (Fig. 6) and verified on planigraphic study. An opportunity was afforded, also, to follow response to therapy roentgenographically, with reduction in width of the thickened, apparently fibrinous pericardium. All of the reproductions of roentgenograms herein presented have been photographically retouched to permit adequate visualization of the sub-

epicardial fat and the adjacent pericardial shadow. Reproduction of the fine shadows discussed would not have been otherwise satisfactory.

DISCUSSION

The roentgen demonstration of a subepicardial fat layer and the resultant pericardial outline offers definite information of clinical significance. A normal appearing pericardial shadow, *i.e.*, one which is clearly delineated and not more than 1 or 2 mm. in width, must indicate that no pericardial thickening is present, suggesting strongly that no significant affection of the pericardium has occurred in the past. Conversely, a pericardial shadow of more than 2 mm. in width must signify either current or previous pericardial thickening by fibrin deposition or fibrosis. Close correlation of roentgen and clinical findings is here, as in any other roentgenologic endeavor, essential for proper evaluation.

If the subepicardial-pericardial shadow pattern obtains in a given case of pericarditis, whether the primary disease be rheumatic, tuberculous, or of an acute benign type, opportunity may be afforded to follow the course of the disease process and response to therapy by planigraphic study of the left heart border at suitable intervals of time. An excellent demonstration of this is presented in the clinical history here recorded. The ability to assess the progress of the disease process is well shown in Figures 7-10.

Similar diagnostic aid is afforded in some instances of non-loculated pericardial effusion. Experience with this roentgen sign as it appears in this phase of pericardial disease is as yet limited. Observations from other sources will undoubtedly contribute to further assessment of its value. It would appear that, unless an unusually heavy deposition of subepicardial fat is present, a large collection of pericardial fluid or exudate over the anterior and posterior heart as well as along the left border would obscure, by its increased density, the subepicardial fat layer and the

adjacent pericardial shadow. In instances of small or moderate effusion or exudation, however, there may again be afforded a significant diagnostic aid. In such instances a widened shadow is seen lateral to the subepicardial fat layer such as is encountered with pericardial thickening, the roentgen density of the fluid and tissue shadows being approximately equal.

It is conceivable that in rare instances information may be obtained relative to the presence of pericardial cysts, diverticula, or tumors, if the pericardial shadow is visualized. Opportunity for such observation has not been afforded to date, however.

It is not implied that the utilization of this roentgen sign will supplant other clinical, roentgen, or laboratory procedures in the diagnosis of pericardial disease. It is believed, however, that an additional factor in evaluation of a normal cardiac shadow is afforded in the small but significant percentage of chest roentgenograms in which the subepicardial-pericardial shadow is seen. In a similar manner, an additional roentgen diagnostic aid is available in the study of pathologic states of the pericardium.

SUMMARY

1. A roentgen sign not previously described is afforded by visualization of the relatively radiolucent subepicardial fat layer, permitting demonstration of the adjacent parietal pericardium seen in sagittal section as a positive linear or curvilinear shadow along the left heart border.
2. The gross and microscopic anatomy underlying demonstration of a subepicardial-pericardial shadow pattern on the roentgenogram of the chest is discussed.
3. Roentgen demonstration of a subepicardial fat layer, though occurring in only a limited number of instances, affords visualization of either a normal or thickened adjacent parietal pericardium. Demonstration of non-loculated pericardial effusions may similarly be obtained.
4. The course of pericardial disease with pericardial thickening or effusion

may be followed at intervals, preferably by planigraphic study, and response to therapy evaluated.

NOTE: The author acknowledges gratefully the advice and direction of Dr. J. Gershon-Cohen, Director of the Department of Radiology, Albert Einstein Medical Center, Northern Division. He is also indebted to Dr. Henry Brody, Pathologist and Director of Laboratories of the same institution, and to his able assistants, for their help in making available suitable postmortem material for this study.

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SUMARIO

Observación de la Sombra Pericardíaca en la Radiografía Torácica Corriente: Nuevo Hallazgo Roentgenológico. Comunicación Preliminar

Un signo roentgenológico que no había sido descrito antes ha sido suministrado por la visualización, en un número limitado de individuos, de la relativamente radiolúcida capa adiposa subepicardíaca. Esto permite la observación del adyacente pericardio parietal, que en el segmento sagital aparece en forma de sombra lineal o curvilinea a lo largo del borde del corazón izquierdo. Una sombra pericardíaca de aspecto normal, es decir, que esté netamente demarcada y no tenga más de 1 ó 2 mm. de ancho, indica que no existe engrosamiento pericardíaco y sugiere elocuentemente que no ha habido en el pasado afección importante del pericardio. En cambio, una sombra pericardíaca dilatada

denota engrosamiento pericardíaco actual o anterior por depósito de fibrina o fibrosis.

Aunque el signo es observable en la radiografías corrientes del tórax, cuando existe dilatación de la sombra, las exposiciones planigráficas aprontan notable prueba corroboradora del hallazgo anormal.

Preséntase un caso en el que se demostró, al descubrirse el signo precitado, que un enfermo que se creía tenía infarto miocárdico, padecía realmente de pericarditis. Los planigramas confirmaron la presencia del signo observado en una radiografía corriente y suministraron pruebas de la respuesta al tratamiento durante un período de varios meses.

Total Myelography

Complete Visualization of the Spinal Subarachnoid Space¹

J. T. BRIERRE, M.D., and J. A. COLCLOUGH, M.D.

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WE BELIEVE that the technic to be described is a worth-while addition to previously advanced methods for examination of the spinal subarachnoid space. It is a modification of two means of demonstration of this space described by Bell, Wunderlich, Fett, and Pool (1) and by Malis, Newman, and Wolf (2). The first-named authors advocated the physiological upright position as an aid in the diagnosis of lumbar intervertebral disk herniations. The latter three, in January 1953, described their full-column technic in lumbar disk myelography.

Our method, in use since early in 1953, permits radiographic examination of the spinal subarachnoid space with less discomfort to the patient. It reduces exposure. Effort on the part of surgeon and radiologist is diminished. The time required for this diagnostic procedure is lowered. The fluoroscopic pursuit of a small, fragmenting amount of radiopaque material up and down the spine, particularly over the dorsal kyphosis, is eliminated. The percentage of error is decreased. Finally, the degree of inversion of the body is cut down, an advantage greatly appreciated by the patient.

The patient lies flexed in the lateral recumbent position. A spinal puncture is done in the lumbar region. If a disk herniation or other lesion is suspected in the lower spine, puncture should be done above or below the neurologically indicated level. Passage of the needle at the site of a lesion is much more difficult; it is frequently painful, and the contrast medium is less easily removed. If a lesion is suspected in the upper lumbar, thoracic, or cervical region, the fourth lumbar intervertebral space is usually best. Spinal fluid pres-

sure is recorded, and the cerebrospinal fluid dynamics observed. Fluid is collected for laboratory examination if the pressure is not increased.

The patient's head is now elevated slightly, and 21 c.c. of ethyl iodophenyl-undecylate (Pantopaque) is injected into the subarachnoid space. The needle is withdrawn, and the patient straightens out and lies prone. His feet are then placed in contact with the footboard, and the table is brought to the vertical. He then takes a few steps around the room, flexes and extends the spine if the surgeon thinks this is indicated, and returns to the table. The lumbosacral region is observed fluoroscopically and appropriate positions are selected for filming.

The patient then faces the table and is returned to the horizontal. He next turns to the supine position, and by this simple maneuver complete filling of the thoracic region is accomplished. Fluoroscopy is done and films are exposed as desired. The head should be kept slightly elevated during this part of the examination to prevent cascading of the medium beyond the cervical region.

The patient now returns to the prone position and is suitably supported. With his neck in extension, the table is tilted head downward. In none of the cases examined to date has it been necessary for the downward tilting to exceed 45 degrees to obtain visualization of the cervical area.

After completion of the examination, the patient is allowed to sit up for a few minutes. He then returns to the lateral recumbent position, and a second lumbar puncture is done. With the needle in place, he turns to the prone position and the radiopaque material is removed.

The accompanying figures illustrate the radiographic visualization of the lumbo-

¹ Accepted for publication in November 1953.

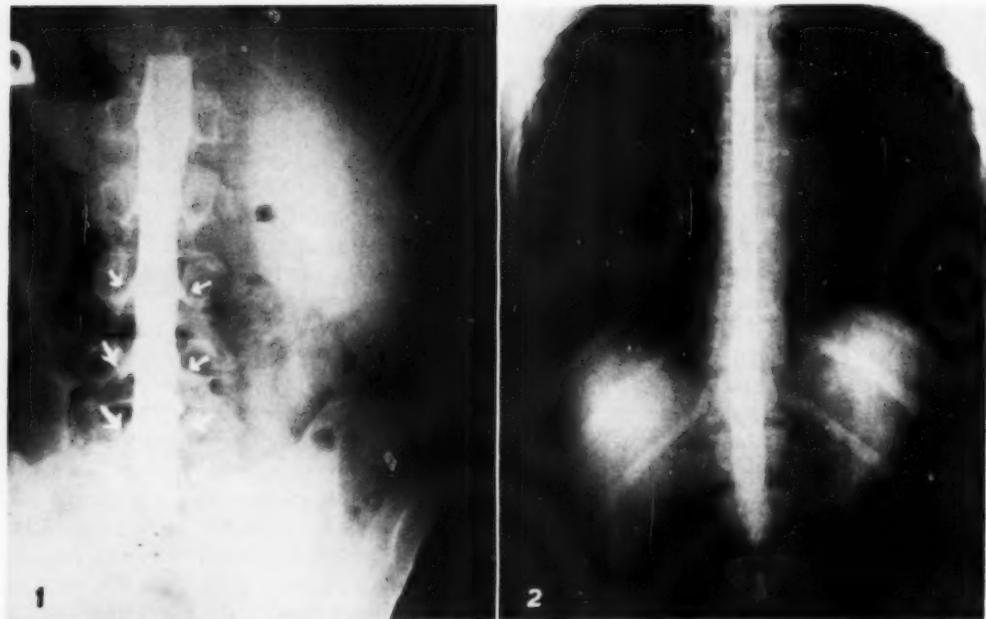


Fig. 1. Normal filling of the lumbosacral subarachnoid space. Note passage of Pantopaque along the nerve sheaths through the intervertebral foramina.

Fig. 2. Demonstration of the normal thoracic region by subarachnoid Pantopaque.

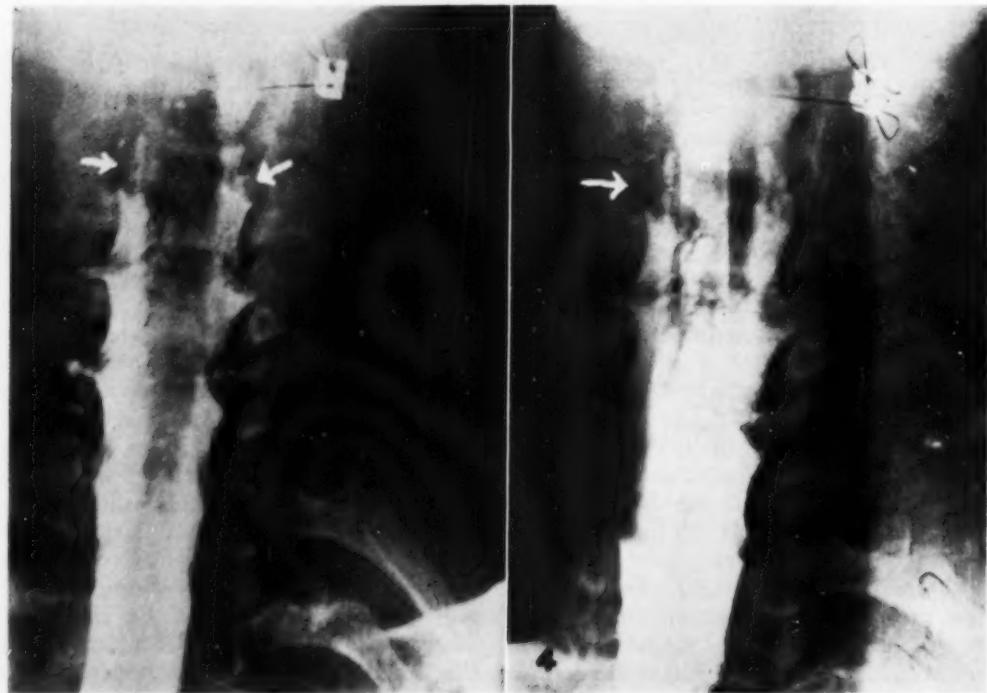


Fig. 3. Central cervical disk protrusion.

Fig. 4. Lateral protrusion of a herniated cervical disk.

sacral, thoracic, and cervical areas. Figures 1 and 2 demonstrate normal filling of the lumbosacral and thoracic subarachnoid spaces. Figure 3 shows an almost complete block by central protrusion of a cervical disk. Figure 4 reveals a lateral cervical protrusion. Figure 5 shows what we interpreted as varicosities of the thoracic cord. At surgery, this was found to be a case of pia-arachnoiditis binding the posterior roots to the dorsal surface of the cord, with obliteration of the subarachnoid space, corresponding throughout the surgically exposed area to the radiographically demonstrated filling defect.

The following features are worthy of note:

First, the ease of handling the patient for lumbar visualization in the erect position. It has been found that the 21 c.c. of ethyl iodophenylundecylate instilled will usually fill the distal subarachnoid space to levels varying from the first lumbar to the eleventh thoracic interspace. If lumbar study alone is to be done, the needle need not be withdrawn. Fluoroscopy can be eliminated and the study made from films alone.

Second, as suggested by Bell, Wunderlich, Fett, and Pool, having the patient walk and remain erect may cause sufficient additional protrusion of a lumbar disk to permit its visualization when it might not otherwise be demonstrable.

Third, the method permits study of the entire thoracic region simply by having the person examined assume the supine position. Removal of the needle and a second lumbar puncture are required, but this has not been as distressing to our patients as has repeated manipulation.

Fourth, it allows examination of the thoracic and cervical portions without excessive inversion of the patient. In the past, many patients have complained bitterly and become quite apprehensive when turned almost completely upside down.

Fifth, it has been found that removal of the radiopaque liquid is much easier when the large amount is used. This is attrib-

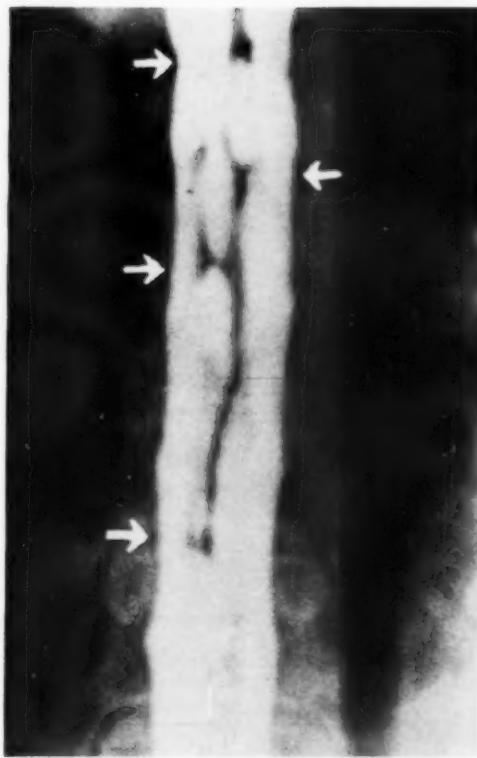


Fig. 5. Demonstration of varicosities of the thoracic cord.

uted to the fact that the needle more easily penetrates the medium. The depth of the mass plus its weight is thought to aid in breaking its surface tension. This same surface tension causes the entire mass to be drawn to the needle when suction is applied.

Sixth, there is noticeably less globulation when larger quantities of the medium are used.

This method has been found to be more accurate in our hands than any other described. To date, 18 patients have been examined, of whom 15 have been operated upon. There have been no false positives and no false negatives. There has been no complaint attributable to the amount of contrast material used.

We believe that this technic, correctly followed and correctly interpreted, will definitely prove or disprove the presence or absence of lumbar, thoracic, or cervical

disk herniation. There has been much discussion concerning the accuracy of myelography in the exclusion of lumbar disk herniation. Apparently, the consensus of medical opinion is that it is not excluded by negative myelography with the older technics. In Figure 1, it will be seen that the contrast medium is easily visualized as it has passed along the neural cuffs all the way out through the intervertebral foramina. With the patient in the erect position, it is inconceivable to us that pressure upon a nerve by lumbar disk herniation sufficient to cause sciatica can exist with such visualization. We believe that, from a medicolegal point of view, this is significant.

In summary, there is little of originality in the work we have done or in our method of doing it. Due credit is extended to

those whose methods have been utilized and expanded. We feel that 21 c.c. of ethyl iodophenylundecylate is enough in the average case to provide complete radiological visualization of the lumbosacral, thoracic, and cervical subarachnoid spaces. Total demonstration is accomplished with a minimum of manipulation and discomfort to the patient, a reduction of time, exposure, and effort for the surgeon and radiologist, and an increase in the accuracy of the examination.

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SUMARIO

Mielografía Total. Completa Visualización del Espacio Subaracnoideo Raquídeo

Los AA. han modificado técnicas mielográficas descritas por otros para obtener la observación total del espacio subaracnoideo raquídeo (lumbar, dorsal, y cervical) para el diagnóstico de las hernias de los discos intervertebrales. Se ejecuta el examen con 21 c.c. de yodofenilundecilato etílico (Pantopaque), con el enfermo

erguido y recostado. Se requiere un mínimo de manipulación, se ahorra tiempo, se rebaja la proporción de exposición, y en particular se reduce el grado de inversión requerido del cuerpo.

En el examen de 15 enfermos operados después, no se obtuvieron ni positivas ni negativas falsas.



Arteriovenous Fistula of the Renal Vessels

A Case Report¹

GEORGE J. BARON, M.D., and RICHARD H. KOENEMANN, M.D.

ARTERIOVENOUS fistula of the renal vessels is an exceedingly rare abnormality. Review of the literature reveals only four such cases previously reported. Since the presence of a thrill or a bruit is a prominent clinical finding, it seems probable that the lesion can be suspected solely on the basis of the physical examination. We report here the fifth proved case and the first such case secondary to trauma.

CASE REPORT

A 7-year-old girl was admitted to the Genesee Hospital for evaluation of hypertension. Approximately eighteen months prior to admission, she had fallen on a flight of stairs while carrying milk bottles. A report from the hospital at which she was treated at that time revealed that she was admitted in surgical shock. A puncture wound, 2 cm. in length, was found at the level of the eleventh rib in the left mid-axillary line. An exploratory operation was performed through a left supracostal incision, and a large retroperitoneal perforation of the descending colon, corresponding to the penetrating wound of the abdomen, was noted; blood and fecal material were spilled into the surrounding area. The kidney and perirenal structures appeared unaffected. The perforation was closed, and a drain was brought from the area through the wound. Additional treatment consisted of penicillin and streptomycin. Recovery was gradual but satisfactory. The patient's blood pressure was normal throughout hospitalization and was recorded as 108/60 on the fifth day after injury.

About fifteen months prior to her admission to the Genesee Hospital (three months after the injury), the child began to complain of frontal headache. At first, she averaged about three attacks a week, which were relieved by aspirin. During the past fifteen months, however, the headache had increased both in frequency and severity until at the time of the present admission it was almost constant. Recently her attending physician had noted a persistent hypertension.

The past history was negative except for some enuresis, but this was evident before as well as after the accident.

The patient did not appear in any distress on the admission physical examination. The temperature was 99°, the pulse 94, and respirations 20.



Fig. 1. Elongation of the lower pole infundibulum and slight irregularity of the margin of the pelvis on the left side demonstrated on an intravenous pyelogram.

The blood pressure was recorded as 146/110. The heart was normal on percussion and auscultation. The eye grounds were negative. The abdomen showed a well healed scar, 4 to 5 inches long, in the left epigastrium, extending toward the left flank, and a second scar of a half-inch incision in the left flank.

Laboratory findings were as follows: hemoglobin 13.1 gm., red blood cell count 4,400,000, and white cell count 7,500; blood smear differential count and urine examination normal; blood non-protein nitrogen 27 mg. per cent. An electrocardiogram was interpreted as normal.

On the second hospital day an intravenous pyelogram (Fig. 1) was made and interpreted as follows. "The right side appears normal. On the left side the calyces of the lower pole appear elongated and the infundibulum narrowed. The inferior margin of the kidney pelvis, and to a lesser extent the su-

¹ From The Genesee Hospital, Rochester, N. Y. Accepted for publication in December 1953.



Fig. 2. Retrograde pyelogram showing the same findings as the intravenous pyelogram.

terior margin, is slightly irregular. The uretero-pelvic junction is not clearly seen. The conclusion is that the changes could be due to a mass in the lower medial portion of the kidney." Subsequently, the attending physician felt a thrill and heard a bruit over the left kidney.

Two days later a retrograde pyelogram (Fig. 2) confirmed the findings on intravenous pyelography. A chest roentgenogram was obtained and a ballistocardiogram was taken, both of which proved to be normal.

On the ninth hospital day a left nephrectomy was performed. The vessels of the kidney were injected with Diodrast and the specimen was radiographed (Fig. 3), showing an arteriovenous aneurysm.

The pathological report was as follows: "The specimen consists of a 49-gm. kidney from which the capsule strips with ease, revealing a smooth surface, except for the anterior surface of the lower pole, where there is a depressed, scar-like area. On examination of the pelvic vessels, it is noted that the artery and vein entering the lower pole are enlarged. On tracing these vessels into the lower pole, a common aneurysmal space, measuring approximately 1 cm. in all dimensions, is found. The cortex overlying the area measures perhaps 4 mm. On section elsewhere the parenchyma is seen to be a red-brown in color, with a cortex measuring 6 mm.

Glomeruli, pyramids, arcuate arteries, calyces, pelvis, and ureter appear unremarkable.

"Sections taken from the lower pole show areas of cortical scarring with linear infiltration of lymphocytes through the medulla to the cortex. Glomeruli in this area show thickening of Bowman's capsule and some fibrotically obliterated glomeruli. Encroaching on the cortex is a space lined by fibrous tissue and smooth muscle.

"Conclusion: Varicose arteriovenous aneurysm within the lower pole of the left kidney with con-

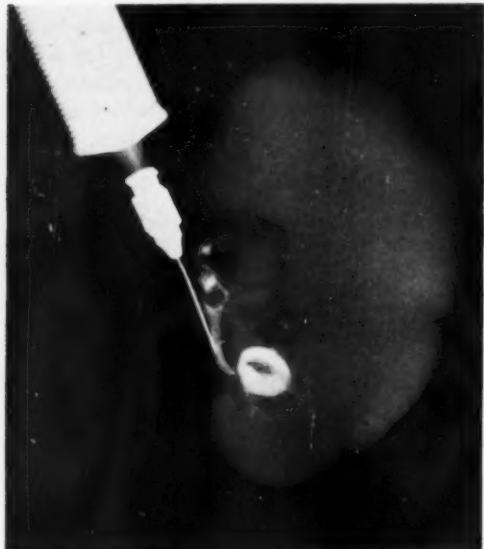


Fig. 3. Injection of the specimen with radiopaque material following operation, showing the aneurysmal sac.

comitant scarring and focal chronic pyelonephritis of the lower pole."

Prior to surgery the blood pressure remained elevated. It was 120/80 on the second day following surgery and remained at approximately that level throughout the remainder of the hospital stay. The postoperative course was uneventful, and the patient was discharged ten days postoperatively with a diagnosis of hypertensive vascular disease secondary to traumatic left intrarenal arteriovenous fistula.

DISCUSSION

Varela (1) reported the first example of arteriovenous fistula of the renal vessels in 1923. The lesion was believed to be secondary to erosion from a congenital aneurysm of the renal artery. Rieder (2) in 1942 presented a case which again was thought to be due to a congenital aneurysm, though the patient did have a history of

previous right flank injury. In 1947, Pearse and MacMillan (3) reported a case of arteriovenous aneurysm in which the only clinical finding was spontaneous hemorrhage. More recently, Hamilton, Getz, and Jerome (4) described a patient with this lesion in whom the fistula was associated with adenocarcinoma of the kidney. In this latter case, tumor was seen grossly to be filling the renal vein.

From these few published cases and the one reported here, it is seen that the etiologic factors thus far known in the development of arteriovenous fistulas of the renal vessels are congenital aneurysms, tumor, and trauma. In a rare case this lesion may be an explanation for hypertension. The prominent clinical finding is a thrill or bruit over the affected kidney. Pyelography may show a defect indicating the site of the involvement, but the findings on the pyelograms are not pathognomonic of the specific lesion. With the more frequent use of angiography, it may be possible actually to visualize the arteriovenous communications. This possibility, at least, is suggested by the clear delineation of the lesion obtained by injection of the opera-

tive specimen in the case described here (Fig. 3).

SUMMARY

A case of arteriovenous fistula of the renal vessels is presented. This is a rare entity characterized clinically by a thrill or bruit. It may be an unusual cause for hypertension. The etiologic factors thus far known are congenital aneurysm, tumor, and trauma. Intravenous or retrograde pyelograms can be of help in localizing the site of the fistula. It is suggested that angiography may in the future offer a specific preoperative diagnosis.

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SUMARIO

Fistula Arteriovenosa de los Vasos Renales

Presentase un caso de fistula arteriovenosa de los vasos renales. Trátase de una entidad rara, caracterizada clínicamente por un estremecimiento o ruido, que puede ser una causa poco común de hipertensión. Los factores etiológicos conocidos hasta ahora son aneurisma congénito, tumor y traumatismo. Los pielogramas intravenosos o retrógrados pueden ser de ayuda para localizar el sitio de la fistula.

En el caso actual, la enferma era una niña de siete años con historia de traumatismo abdominal año y medio antes. La pielografía intravenosa y retrógrada reveló alteraciones que aparentemente podían deberse a una tumefacción en la porción media inferior del riñón, y se ejecutó una nefrectomía. Al inyectarse Diodrasto en los vasos renales y radiografiarse el ejemplar, apareció el aneurisma arteriovenoso.

Inferential Kilovoltmeter

Measuring X-Ray Kilovoltage by Absorption in Two Filters¹

ROBERT R. NEWELL, M.D.,² and GEORGE C. HENNY, M.D.³

IF X-RAY TUBES gave monochromatic radiation, specification of quality could be given equally well as kilovolts, half-value layer (h.v.l.), or absorption coefficient (μ in any named material). But since the radiations we use clinically are heterogeneous, we feel it necessary to give all the factors which influence the wavelength composition (the spectrum) significantly, namely the voltage and the filter, as well as the h.v.l.

In the pioneer days, the only convenient way to measure high voltages was by spark-gap, which for pulsating voltages measures the peak voltage (kvp), not the effective voltage. In the early days the quantity of radiation was hard to measure, too, and it was customary to infer the quantity from the tube voltage, current, and time. Since output increases very rapidly with voltage, and since penetration also increases very rapidly with voltage in the range available in those days, this factor came to have a dominating position in the radiologist's thinking. Nowadays we have good means of measuring quantity and quality of x-rays, but our biased attitude toward voltage persists. We now know that comparatively gross differences in quality make but small differences in clinical application. Nevertheless, in working out new roentgenographic techniques and in checking calibrations of machines, precise knowledge of the kilovoltage is very desirable.

Modern shock-proof apparatus makes it inconvenient to bring out the high tension for measurement by sphere-gap. The radiologist must accept the manufacturer's calibration of kilovolts peak against line voltage, with tabular (or built-in) corrections for the several tube loadings. He is

naturally skeptical of these calibrations, because the same exposure at the same kilovolt setting fails to give the same density in the roentgenogram on two different machines.

It is possible to infer the voltage on the tube from the hardness of the radiation. If the voltage is pulsating, the inference is not from the peak voltage, but from the effective voltage. The greater the thickness and the higher the atomic number of the filter used for a given kilovoltage, the harder the transmitted radiation will be and the nearer the effective voltage will approach the peak voltage. It is, of course, really the hardness itself that is of clinical significance. But our thinking has been done all these years in terms of kilovolts as the measure. We are not here defending this illogical attitude. We are proposing, rather, to yield to the prejudice and describe an instrument to measure the hardness and give the reading in the terms requested, namely kilovolts.

CONSTRUCTION OF THE KILOVOLTMETER

The inferential kilovoltmeter (Fig. 1) consists of two ionization chambers, each of which is surrounded by its own filter. The larger ionization chamber is twenty times as sensitive as the smaller one. The chambers are held parallel to each other by two aluminum tubes, one 3.5 mm. thick and one 2 mm. thick. These tubes are part of the filter system and are firmly fastened to a rectangular brass base plate 1/8 inch thick. There is a cover, as shown, similar to the base. The brass cover and base are rectangular so that the voltmeter may be placed on its side if a vertical x-ray beam is used, or on its end for a beam directed horizontally. The less absorbing of

¹ Presented as an Exhibit at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13-18, 1953.

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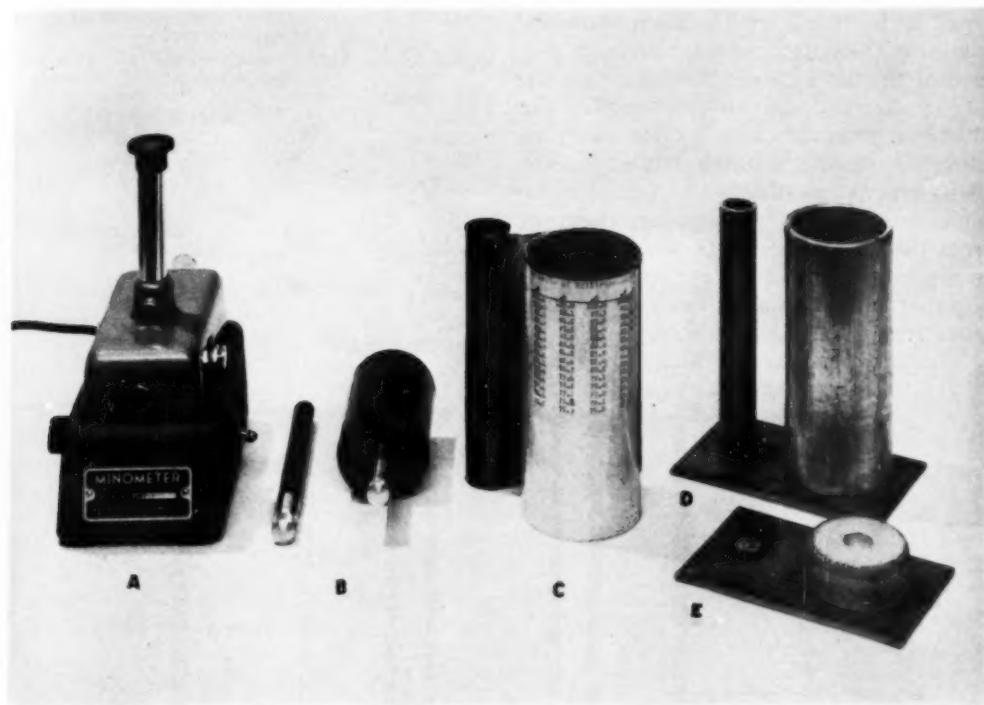


Fig. 1. The kilovoltmeter disassembled. From left to right: The Victoreen Minometer (A) with 0.2-r and 0.01-r ionization chambers (B). One set of filters on which the calibration table is mounted (C). Aluminum cylinders mounted on a brass base (D). The chambers fit inside these cylinders and supplementary filters slip over their ends on the outside. The removable tops (E) are then put in place.

the two filters is thick enough to make uncertainty in intrinsic filtration of the x-ray tube window comparatively unimportant. At the same time interfering effects of scattered radiation are reduced. The less absorbing filter holds the less sensitive (smaller volume) chamber. The more absorbing filter is enough heavier to make the two chambers give about equal deflections (20:1 ratio of roentgen readings) in the middle of the voltage range to be covered. The ends of the cylinders must be covered with material which is heavy enough to keep out scattered radiation. The ionization chambers are not equal in length, so that a spacer of low density is placed at the end of the shorter one, thus bringing the centers of the air volumes to the same level (Fig. 2). This facilitates proper alignment of the voltmeter in respect to the x-ray tube focal spot. The

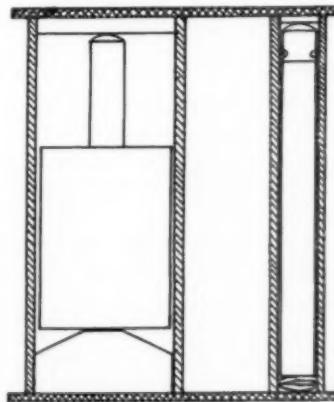


Fig. 2. Cross section of the voltmeter showing the positions of the ionization chambers and of the filters and end pieces.

chambers are separated a bit from the end plates so that they will not be shaded if the voltmeter is ill-centered in the beam. A

small spring made of fine piano wire and placed in the bottom of the aluminum portion of the filter causes the 0.2 r chamber to rise when the end cap is taken off. The chamber protrudes and is thus easily removed for reading in the electrometer. Supplementary pairs of filters are added to the aluminum filters by slipping them on from the top. One set of filters is shown in Figure 1. These are conveniently held together by continuing the copper sheet from one to the other as shown.

The kilovoltmeter operates on the basis

TABLE I: SETS OF FILTERS USEFUL FOR THE KILOVOLT RANGE INDICATED.

Ionization Chamber	Material and thickness of filter in mm.			Kilovolt range
	Pb	Tin	Copper	
0.2 r	0	0.13	2.0	40-55
0.01 r	0	0.56	3.5	
0.2 r	0	0.75	2.0	50-70
0.01 r	0	1.67	3.5	
0.2 r	0	0.75	2.0	70-100
0.01 r	0.4	1.0	3.5	
0.2 r	0.8	0.56	2.0	95-120
0.01 r	2.0	0.56	3.5	
0.2 r		0.75	2.0	150-200
0.01 r	0.5	0.3	1.0	3.5

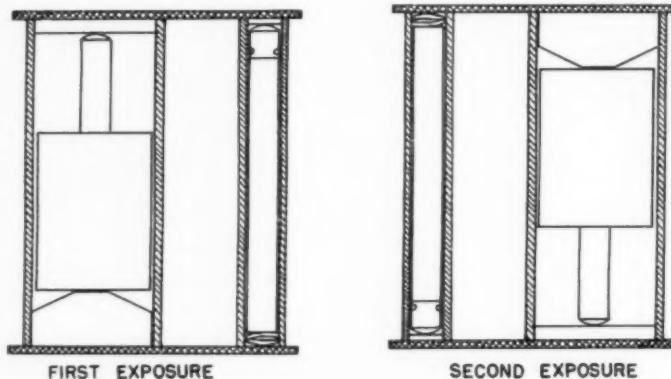


Fig. 3. Diagram of positions of the voltmeter to compensate for small variations in uniformity of the x-ray field. The first measurement is made as shown on the left. The voltmeter is then turned over, keeping the same surfaces of the filters toward the x-ray tube, as shown on the right.

of the difference in attenuation, not on the basis of difference in atomic number of the two filters. The filter materials are chosen for convenience, but should not have an absorption discontinuity in the kilovoltage range of interest. The thicknesses are chosen to give convenient range and sensitivity. Heavier filters lessen the effect of intrinsic filtration and increase the sensitivity, but shorten the kilovoltage range and also require longer exposures. Some of the filter combinations which have been satisfactory are listed in the accompanying table.

CALIBRATION OF THE INSTRUMENT

A calibration for each set of filters must be made by exposing the voltmeter in a beam of x-rays from a tube operating at

various known kilovoltages. A ratio of milliroentgens on the two chambers is obtained for each known kilovoltage. Such a calibration is shown for constant potential (Fig. 4) and for pulsating potential (kvp), (Fig. 5). The relation between these calibrations depends upon the actual filters used and also on the voltage wave form and the tube used.

USE OF THE INSTRUMENT

Measurement of tube voltage (inferential) is made by putting each charged chamber in its filter and setting the voltmeter across the x-ray beam (the centers of the chambers being the same distance from the focal spot) at a distance sufficient to insure that the beam covers both chambers completely. With line-focus tubes

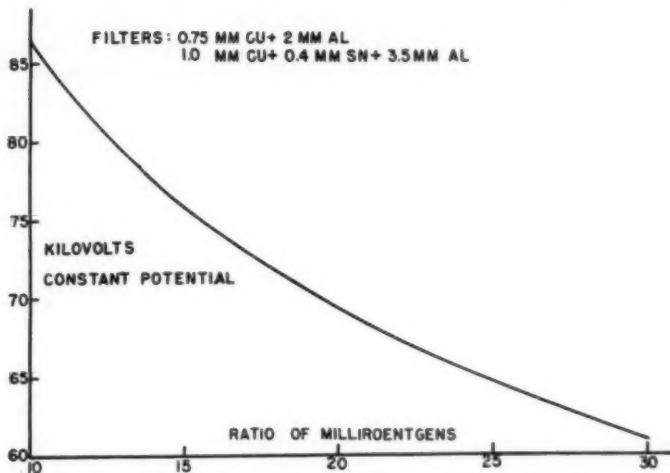


Fig. 4. Calibration curve on constant potential of filter pair shown in Fig. 1.

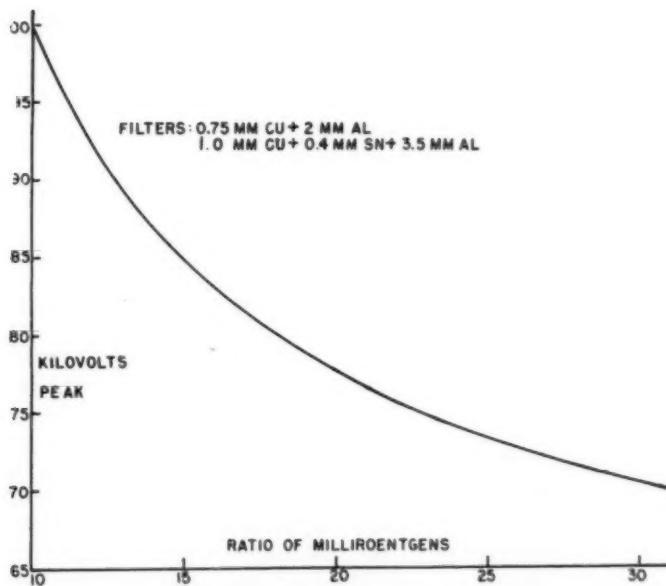


Fig. 5. Calibration curve on pulsating potential of filter pair shown in Fig. 1.

care must be taken not to have the "heel" of the target cast a shadow on the chambers. An exposure is made at the chosen setting, long enough to make the readings conveniently large, but neither one off scale. In order to avoid error due to unevenness of radiation across the beam, the exposure may well be repeated with the voltmeter rotated 180° (Fig. 3). The same

surfaces of the filters should always face the x-ray tube.

From the ratio of the readings of the two chambers, the inferential voltage is read off the calibration chart. Examples of such charts are shown in Figure 4 for constant potential, and in Figure 5 for pulsating.

For short exposure times (high milliam-

peres), the exposure is repeated as often as needed to bring the accumulated exposure of the voltmeter up to the desired convenient readings. It is important to avoid errors from recombination of ions in the ionization chambers when very high intensities are used. When the intensity is very high, the high density of ionization in the chambers allows some recombination of ions before they can all be swept out by the electric field. Some of the ions which are produced are therefore not measured. The Victoreen 0.01 r chamber will read too low if x-ray intensity is so great as to give full scale deflection in less than half a second.

To test for saturation in the chambers the following procedure may be used: If at the same setting the ratio of milliroentgens does not come out the same when the exposure is broken into two equal parts as when it is given continuously, one can suspect unsaturation in the ionization chamber. On one occasion, an error of 20 per cent was observed when full-scale exposure was given in $1/120$ second, but was negligible when the chamber was moved farther away and the $1/120$ second exposure was repeated four times to obtain full-scale reading.

This kilovoltmeter is convenient to use, as it requires no connections to the high-voltage circuit. It can be used on low or high milliamperage technics and thus measures the voltage as it is actually applied to the x-ray tube. The only skill that is required in its use is the ability to charge the ionization chambers and to read the deflections of the electrometer fiber properly on the correct scale. Dividing the larger number of milliroentgens by the smaller number gives a ratio. From the ratio the kilovoltage is found on the calibration chart.

RANGE AND ACCURACY

By the use of different filter combinations (both thickness and material) the instrument may be made very sensitive over a narrow range, or less sensitive over a

wide range. By using ionization chambers whose ratio of sensitivities is greater than 20:1 the sensitivity may be pushed up still higher. The accuracy of the instrument depends upon the accuracy of the calibration and the accuracy with which the ionization chambers can be read. The Victoreen Minometer is not classed as a high-accuracy instrument but with care, and averaging four readings, we have obtained an accuracy of better than 1 per cent.

Many radiologists may wonder why a kilovoltmeter of this type is of importance to them. This may be illustrated by the following experience: An expensive radiographic machine had been installed and was put into routine service. The roentgenograms all appeared to be darker than expected. The milliammeter was checked with a standard instrument and the timer was found to be in order. By exposing films on the same patient on this machine and also on another machine with the same kind of x-ray tube, we found that the films actually were darker than they should have been, and we guessed that the difference was equivalent to at least 5 kvp. In order to check this, the inferential absorption kilovoltmeter was exposed to the x-ray beam and the measurement indicated that the voltage was 6 kvp higher than the machine calibration indicated. When the manufacturer was informed of this, he said it could not be so. Nevertheless, he sent servicemen down with a sphere-gap and with special adapters to fit into the shock-proof cables. After setting up this equipment, it was found that the x-ray absorption kilovoltmeter checked exactly with the sphere-gap measurements. A change of one connection in the x-ray machine then brought the machine calibration in line with the true kvp and the two machines produced roentgenograms of equal quality.

SUMMARY

The name "x-ray inferential kilovoltmeter" has been given to an instrument

for measuring the ratio of transmission through two different filters. The essential construction of the instrument and its application are described and curves are re-

produced illustrating the calibration of one of the filter sets.

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SUMARIO

Kilovoltímetro Inferencial: Medición del Voltaje de Rayos X por Absorción en Dos Filtros

Se ha impuesto el nombre de "kilovoltímetro inferencial de rayos X" a un instrumento dedicado a medir la proporción de transmisión a través de dos filtros distintos. Consta el mismo de dos cámaras de ionización, cada una de las cuales está rodeada de su propio filtro. La cámara mayor es veinte veces más sensible que la más pequeña, y su filtro es también más absorbente que el de la otra, teniendo un peso suficientemente mayor para que las dos cámaras produzcan desviaciones aproximadamente iguales en el medio de la escala de los voltajes que van a abarcarse.

El kilovoltímetro funciona a base de la diferencia en atenuación, no a base de la diferencia en el número atómico de los dos filtros. Las substancias de que están compuestos los filtros se escogen de acuerdo con la conveniencia, pero no deben mostrar discontinuidad de la absorción en el kilovoltaje considerado. Enuméranse algunas de

las combinaciones de filtros que han resultado satisfactorias.

Hay que ejecutar una calibración de cada juego de filtros exponiendo el voltímetro a un haz de rayos X procedente de un tubo que funcione con varios kilovoltajes conocidos. Se obtiene la proporción de miliroentgens en las dos cámaras para cada kilovoltaje conocido, y se preparan gráficas de calibración para los potenciales constantes y los pulsátiles.

Se mide el voltaje del tubo colocando cada cámara y cargada en su filtro y poniendo el voltímetro a través del haz de rayos X (quedando los centros de las cámaras a la misma distancia del punto focal) a una distancia suficiente para asegurar que el haz cubre totalmente las cámaras. Se hace una exposición en la posición escogida y por la proporción de las lecturas en las dos cámaras se toma el voltaje inferencial de la gráfica de calibración.



Ionization of Air by Beta Rays from Point Sources¹

R. K. CLARK, Ph.D., S. S. BRAR, M.S., and L. D. MARINELLI, M.A.

WITH THE RAPIDLY increasing use of radioisotopes in research, therapy, and radiation protection studies, the problem of accurately determining the distribution of the energy imparted to chemical systems and to biological materials has greatly increased in importance. In the presence of

choice allowed the use of large-dimensioned apparatus, with its relative ease of construction, and permits direct application to denser media of similar atomic numbers, such as tissues.

Since the objective of these measurements was an accurate determination of the

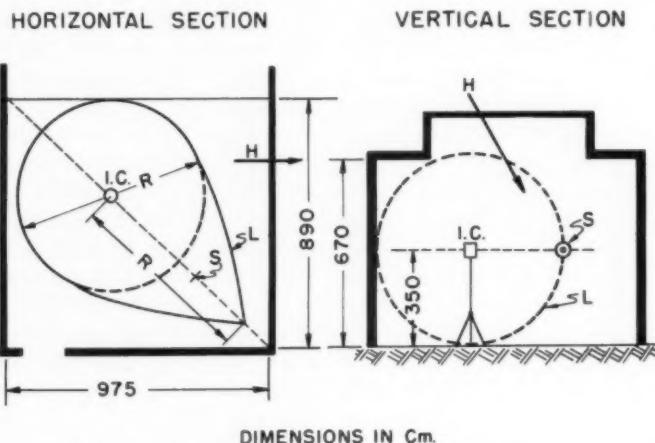


Fig. 1. Plan of the room in which the measurements were made. I. C. Ionization chamber. S. Source. R. Range of P^{32} beta particles, about 680 cm. H. The earth's field. L. Locus of the points from which scattered electrons from P^{32} cannot possibly reach the ion chamber.

beta radiation, the problem is simple only at points in a medium where the concentration is uniform over distances equal to or greater than the range of the emitted particles. Unfortunately this situation is of rare occurrence. In the more usual case, the problem requires: (a) evaluation of the dose as a function of the distance from a point source and (b) integration at a given point of the energy contributed by beta particles originating within the range of the particles. Since knowledge of (a) is required in order to proceed with (b), the investigations reported here were undertaken using air as a homogeneous medium. This

ionization distribution, the principal efforts were directed toward the demonstration that the observed ionization currents were due exclusively to the emitted particles in their undisturbed journey through the air and that all the effects due to solid scatterers or absorbers were properly accounted for. Owing to the special construction of one of our chambers, it was also necessary to prove that all the ions formed in the detecting volume were collected. Because of limitations of space, the many experiments performed will only be outlined here.²

The first step was to select a large room

¹ From the Argonne National Laboratory, Lemont, Ill. Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13-18, 1953.

² A detailed presentation of the methods, apparatus, and computations used in this work is the subject of USAEC Document ANL-5201.

in which to make the measurements (Fig. 1). The source, S, was moved along the indicated diagonal of the room on which the ionization chamber, I. C., was placed. L represents the locus of points beyond which a P^{32} beta particle of maximum energy, elastically scattered, once in its path, could not possibly reach the center of the chamber. Thus it is beyond question that the size of the room was adequate. The possible effects of the earth's magnetic field (indicated by H in the figure) were eliminated by theoretical considerations and by experimental study.

The source was supported by means of a large L-shaped frame dimensioned so that it subtended a solid angle at the source of less than 1.0 per cent, reducing scattering effects to negligible proportions. The source was suspended by means of thin (10 mil) wires and prevented from swinging by similar wires. It was mounted on a thin aluminum washer (Fig. 2) of 6 inches outside diameter and 2 inches inside diameter.

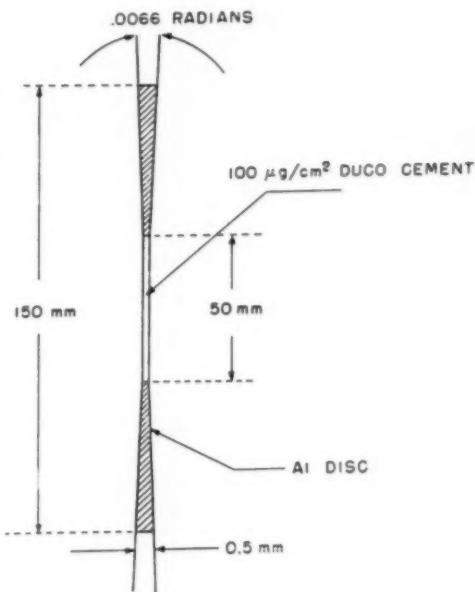


Fig. 2. Beta ray source mounting disk. The dimensions are such that it subtends about 0.5 per cent solid angle at its center.

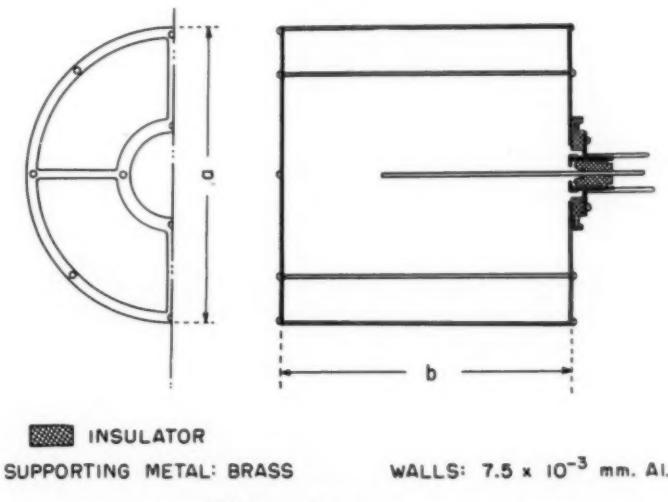


Fig. 3. Thin-walled aluminum ionization chamber.

The central hole was covered with 2 films of Duco Cement (about $100 \mu\text{g./cm.}^2$), between which the active material was dried. The washer was tapered in cross section so that it also subtended only about

0.5 per cent solid angle at its center. Since the thin film was equivalent to only about 1.0 mm. of air, the effect of scattering by the whole source mounting and supporting assembly could be neglected.

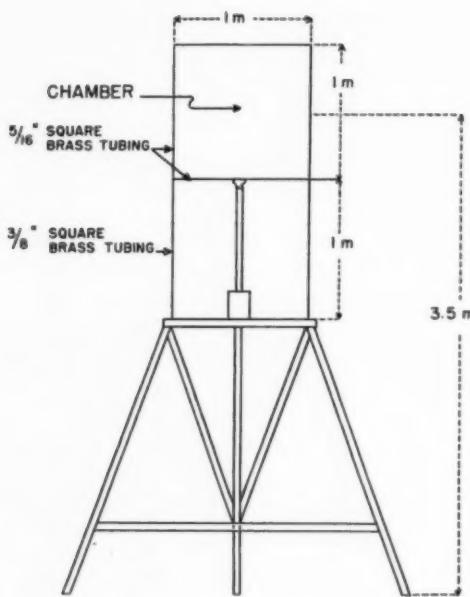


Fig. 4. Front view of grid chamber showing general arrangement, particularly of the major supporting structures.

The chamber shown in the first figure was the type used initially, and was cylindrical with thin aluminum walls (Fig. 3).³ Due to the uncertainty in the effects of the solid walls and their brass supporting posts, this type of chamber was later discarded and a grid type of chamber used in its stead. As shown in Figure 4, the grid chamber was mounted on a framework of slender brass angles and consisted of a set of fine wires attached to small square brass tubing. Figure 5 presents a schematic side view showing the four sets of grids required to form the usual collector and high-voltage electrodes together with the two extra grids on the front and back which were used to delimit anteriorly and posteriorly the collecting field. Figure 6 shows the arrangement of the collecting electrode consisting of sections of insulated wires, the prolongation of which acted as a guard electrode grid system. Figure 7 presents the arrangement of the wires and insulators which was used to accomplish this.

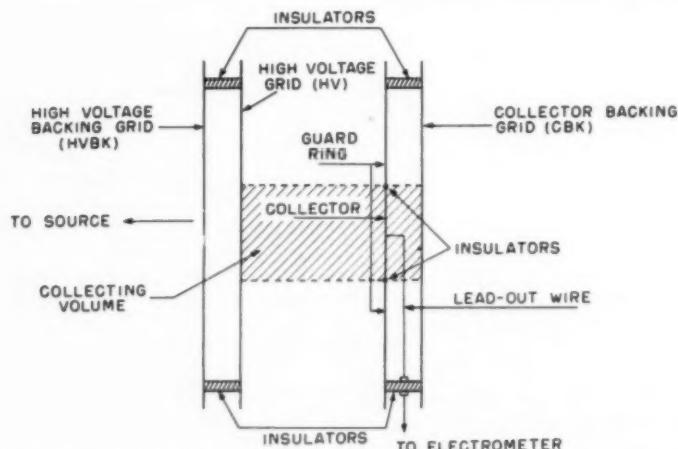


Fig. 5. Schematic diagram of grid chamber: arrangement of the grids in a plane perpendicular to the face of the chamber. (The effect of the lead-out wires was found to be an increase in the effective volume of about 0.75 per cent.)

However, due to its rather large area the possibility remained that it could interfere with the radiation scattered by the air behind the source; this was studied by means of a similar mount which had a large fraction of the aluminum surface removed, and no effect was found.

The insulators were only about 15 mils long by 4 mils diameter, so that the scattering due to their presence was negligible. Since the frame of the chamber and

³ The ionization measurements performed with this chamber were completed in early 1950 and presented at the Sixth International Congress of Radiology (1, 2).

its supports were designed to subtend about a 1.0 per cent solid angle at the center of the chamber, the effect of radiation scattered therefrom was considered negligible, and this was verified by adding dummy sections to the frames supporting the grids so that their area was doubled. Since 2-mil wires were used on a 1.0 cm. spacing, an optical transmission of about

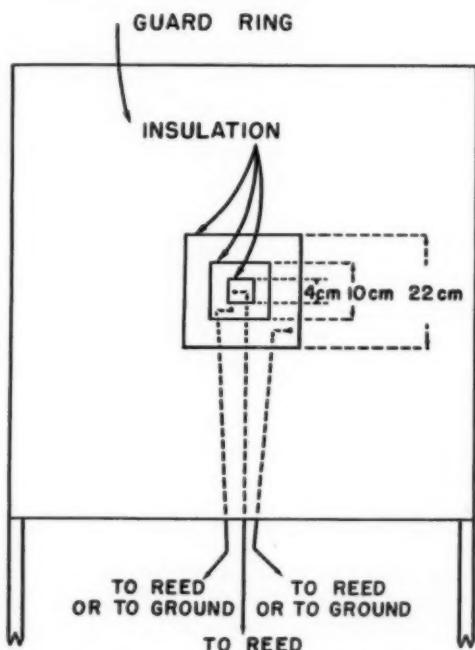


Fig. 6. Collecting electrode of grid chamber. Schematic arrangement of the insulated areas together with the lead-out system by means of which the collecting area could be varied.

99 per cent was achieved. In addition, the possible effects of the wires themselves were studied by replacing them with 1-mil wires. There was a just detectable increase in the observed current, consistent with the change in the optical transmission. Hence it was concluded that the effects of the structures of the chamber and its supports could be neglected.

Since the grid type of chamber is not effectively shielded from pick-up by its own outer walls, it was necessary to build a special shield large enough to include the source and its support. The result was an

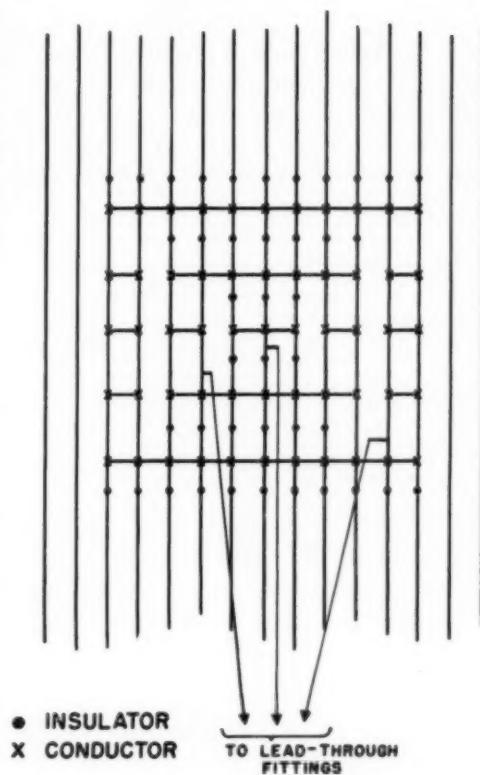


Fig. 7. Details of collecting areas. Schematic demonstration (with a smaller number of wires) of the manner in which the insulated segments were joined to form the collecting areas.

18-foot cube of a tar-paper-backed copper foil draped over a framework of aluminum tubing. This shield, although smaller than the maximal zone of scattering, was proved to be of adequate size by tests involving the construction of a dummy floor which duplicated the position of the nearest surface, namely, the ceiling.

What was perhaps the single most difficult trouble to identify arose from convection currents in the large volume of ionized air within the large shield which caused erratic fluctuations in the collected ion current. The situation arose because the work was being done in the winter, and the top of the room was colder than the bottom. This difficulty was completely eliminated by reversing the thermal gradient.

The position of the source was deter-

mined with the aid of a plumb bob which hung almost to the floor. The distances to the chamber were marked on a steel bar which was accurately set perpendicularly to the face of the chamber by means of a surveyor's transit supplemented with more

errors, particularly in the establishment of the saturation conditions, two types of studies were made. First, measurements were made with a Ce^{141} source to see that the inverse-square law was properly followed over widely different distances.

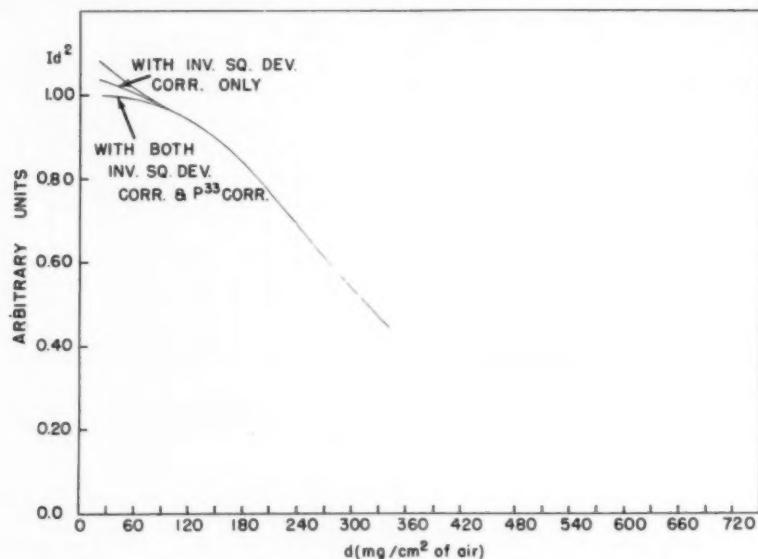


Fig. 8. Final results of the measurements of P^{32} with the grid chamber.

plumb bobs. By these means it was possible to measure the distance from the source to the ion chamber to within a millimeter without difficulty. By experimentation it was shown that the orientation of the source was not critical, and the required height of the source above the floor was determined experimentally.

A rather complex situation arose in establishing whether all the ions produced in the geometrically defined volume of the grid chamber were collected without measuring ions produced elsewhere. This was because it was necessary not only that the collecting voltage be adequate, but also that the field-shaping grid potentials be correct as to magnitude and sign. It was found possible, however, to interpret the occasionally confusing results and to use the proper potentials in taking the final data.

As a final over-all check for systematic

This isotope emits a single gamma ray with an energy of about 146 kev, so that photon-electron equilibrium is maintained up to rather small distances. Having verified the inverse-square law over this range, we were assured of the constancy of the effective volume irrespective of the size of the ionization current. The second type of check consisted of assessing the absolute volume of the chamber by three different methods and comparing these results with the volume as computed from its geometrical dimensions. First, the ionization resulting from a 100-mg. source of radium which had been calibrated by the National Bureau of Standards was observed. This was corrected for lack of secondary electron equilibrium by means of the data reported by Failla and Marinelli (3). Second, a similar measurement was made with a gold 198 source, the roentgen output of which was determined by a thimble chamber com-

parison with the preceding radium standard. Due to the smaller distance required for photon-electron equilibrium, no corrections for this effect were needed. Third, the absolute activity of a P^{32} sample was determined. This was done by

TABLE I. ABSOLUTE VOLUME DETERMINATION, BASED ON KNOWN DOSE RATES FROM VARIOUS EMITTERS, COMPARED TO THE VOLUME AS COMPUTED FROM THE DIMENSIONS OF THE CHAMBER

Geometrical.....	100.0%
Radium.....	97.0%
Gold ¹⁹⁸	101.7%
P^{32}	98.2%

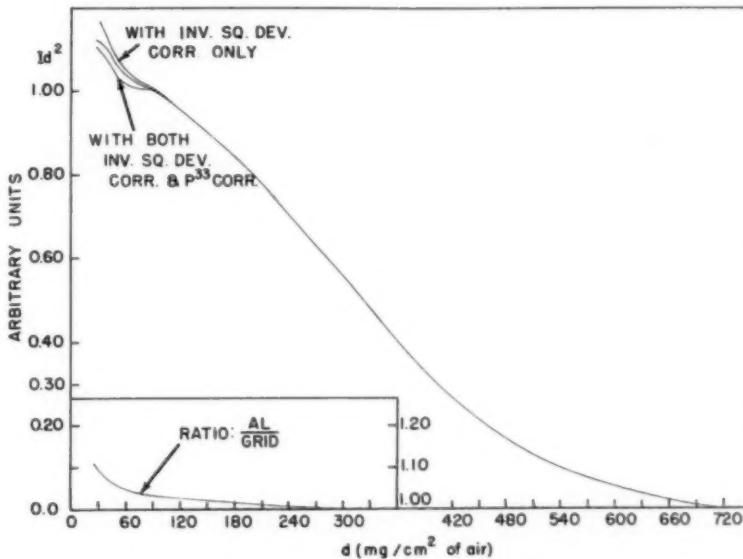


Fig. 9. Final results of the measurements of P^{32} with the aluminum chamber, together with the (smoothed) ratio of the aluminum chamber results to the grid chamber results.

means of an apparatus based on the measurement of the rate of emission of charge as developed in Failla's laboratory (4). This made possible the computation of the total energy emitted by the source, and by integrating the dosage curve found in this study it was possible to calculate the effective volume of the ion chamber. (It was assumed that 32.4 volts are required per ion pair.) The results of these studies are presented in Table I. It is clear from this that there are no systematic errors of significance.

The raw data were corrected for temperature, pressure, background and radioactive decay. The resulting currents measured by a vibrating reed electrometer were ultimately referred to the charging rate of a standard condenser. Finally, for the shortest distances it was necessary to correct for the deviations from the inverse-

square law which resulted from the relatively large dimensions of the ion chamber. This correction was determined by numerical integration and amounted to about 5 per cent at the shortest distance used (about 20 cm. from the source to the center of the chamber).

When phosphorus 32 was used it was also necessary to correct for the presence of P^{32} . This correction was computed from the results reported by Sheline and others (5).

The final results for P^{32} as measured with the grid chamber are given in Fig. 8. This curve stops at about 360 mg./cm.^2 because this was as far as the large shield permitted the source to be moved. Comparison with the results from the aluminum chamber (Fig. 9) shows that the two are in agreement at the larger distances. Thus the final curve for P^{32} (Fig. 10) was produced

TABLE II: SUMMARY OF FINAL RESULTS*

Isotope	d, (mg./cm. ²)	Id ² , Relative Units	Id ² , (micromicroamps/cm. ³) - cm. ² per microcurie
P ³²	22.4	1.000 ± 2%	383. × 10 ⁻⁴ ± 5%
	33.7	0.996	382.
	45.0	0.994	381.
	73.2	0.977	374.
	101.3	0.963	369.
	157.6	0.881	337.
	212.3	0.761	291.
	270.8	0.610	234.
	341.8	0.445	170.
	459.5	0.206	79.
Y ⁹¹	568.1	0.077	30.
	681.1	0.015	6.
	22.5	1.000 ± 2%	401. × 10 ⁻⁴ ± 5%
	33.8	0.992	398.
	45.0	0.970	389.
	73.2	0.923	370.
	101.3	0.883	354.
	158.4	0.772	310.
	215.0	0.645	259.
	328.0	0.375	150.
Tl ²⁰⁴	361.5	0.303	122.
	22.6	1.000 ± 2%	
	34.0	0.888	
	45.4	0.785	
	74.1	0.560	
	102.8	0.379	
	127.2	0.260	
	157.9	0.139	
	214.2	0.033	
	22.5	1.000 ± 2%	
RaE	33.9	0.953	
	45.3	0.873	
	73.8	0.679	
	102.4	0.532	
	159.4	0.317	
	216.5	0.166	

* Since the distance was measured to a fraction of a millimeter, the inclusion of tenths of a milligram per square centimeter is justified. The uncertainty attached to the relative values given are estimated from the results of the studies described in this report. The uncertainty attached to the absolute values includes uncertainty in sampling and in the measurement of the absolute activity.

by joining the aluminum chamber results for the larger distances with the grid chamber results for the shorter distances. The curves presented for the other three isotopes, Y⁹¹, Tl²⁰⁴ and RaE, were all obtained with the grid chamber exclusively. These results are also presented in tabular form in Table II.

As revealed by these studies, the errors in the relative measurements are essentially those due to the limited accuracy of the determination of the ion currents. Adequate corrections were made for those factors studied which did have an additional influence on the observed currents. There remains a possibility, however, of cumulative errors from several of the effects which were individually undetectable. For this reason, it is estimated that the rela-

tive results are not more reliable than within about 2 per cent. In addition to these uncertainties in the case of the absolute measurements, a few other sources of error must be included (such as sampling errors and uncertainties in the absolute volume of the ion chamber). Hence it is estimated that the overall uncertainty in the absolute results is about 5 per cent, which seems adequate in view of the large errors involved in biological studies.

DISCUSSION

The only other measurements in free air which have been published to date were made by Sommermeyer at the University of Freiburg (6). He used a cubical chamber with tissue paper walls and an internally mounted metal-foil electrometer.

When normalized at 50 cm., his results remain within about 2 per cent of ours out to about 160 mg./cm.²; beyond this thickness they rise steadily to about five times ours at about 650 mg./cm.². Unfortunately the meagerness of details in this work precludes any attempt to establish the source of these discrepancies.⁴

the end of the range is not of much significance since the value of Loevinger's function is quite sensitive in this region to the value taken for the range. It should also be pointed out that Loevinger's functional form can give a reasonably adequate representation of the situation with properly adjusted parameters. However, these pa-

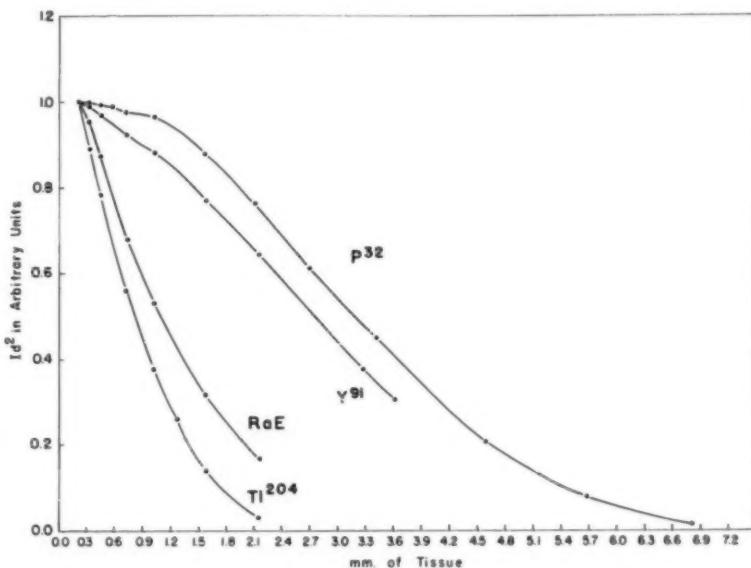


Fig. 10. Summary of the combined final results for the four isotope studies: P³², Y⁹¹, Tl²⁰⁴ and RaE.

The only other work which, to our knowledge, can be compared with the results reported here has been published by Loevinger (7). He used a thin plane source with an extrapolation chamber and showed that the curves for a point source could be deduced from his data by numerical differentiation. Figure 11 presents a comparison of his results with ours for P³², Y⁹¹, and Tl²⁰⁴. This must be considered a good agreement, inasmuch as numerical differentiation is not very sensitive to small differences in the observations. The excessive difference in the two sets of results at

parameters are difficult to predict for other isotopes in the absence of free air data.

Figure 12 illustrates the dose rate in reps per minute obtained in tissue of unit density as a function of distance from point sources of P³² and Y⁹¹. (The rep was considered to be 83 ergs/gm. of tissue.)

Although to our knowledge these data are the most satisfactory of those determined directly in free air, they are incomplete since, owing to circumstances beyond our control, they could not be extended to distances comparable to the dimensions of cells. Despite this incompleteness, it can be seen that for the case of P³², out to distances of the order of 0.5 mm. of water, the dosage rate follows rather closely the inverse-square law; this is a great simplification when dose integrals must be com-

⁴ Through private correspondence with Sommermeyer we have learned that his published data had not been corrected to standard conditions of temperature and pressure as we had assumed. Using the air density as supplied by him, we find his results to be in satisfactory agreement with ours.

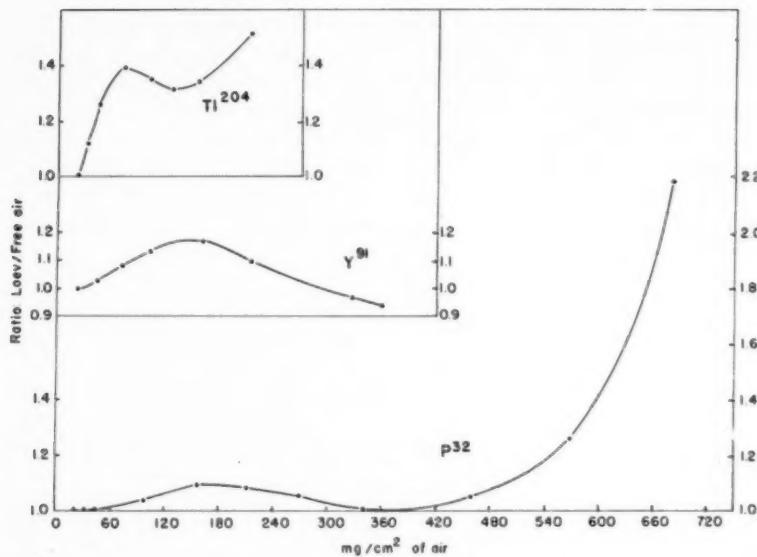


Fig. 11. Comparison of Loevinger's formula with the free-air measurements. The abscissa is distance expressed in mg./cm.^2 of air, with the same scale in each of the three cases. The ordinate is the ratio of Loevinger's values to the free-air measurements.

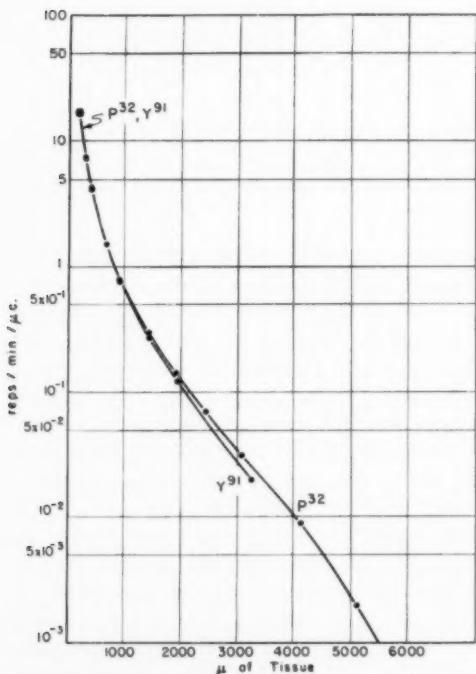


Fig. 12. Dose in tissue of unit density (water). The distance is expressed in microns and the dose in $\text{reps./min.}/\mu\text{c.}$ (1 rep = 83 erg/gram). It is noteworthy that the dosage distribution at short distances is determined almost exclusively by the inverse-square law.

puted in biological systems of small dimensions. It confirms also the view expressed some years ago that, when the concentration in a system varies rapidly within distances much shorter than the range of the particles, the dose is governed in the main by the average concentration of the system.

It should also be emphasized in conclusion that, although these physical data are necessary to the evaluation of hazard in the presence of radioactive particulates, they are in themselves insufficient to predict it, unless the roles played by dosage rate, length of exposure, size of cell population, and other biological parameters are properly evaluated for the particular hazard under consideration.

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SUMARIO

La Yonización del Aire con Rayos Beta Procedentes de Focos en Puntos

Con el uso cada vez mayor de radioisótopos, toma importancia mucho mayor el problema de la determinación exacta de la distribución de la energía impartida a los sistemas químicos y a las substancias biológicas. En lo tocante a la radiación beta, la valuación de la dosis como función de la distancia desde un foco en punto es indispensable para la solución de este problema. Las investigaciones aquí descritas se emprendieron con el uso del aire como medio homogéneo, tomándose precauciones adecuadas para asegurar que las corrientes de yonización descritas se debían exclusivamente a las partículas emitidas en su paso ininterrumpido a través de dicho medio.

Preséntanse los resultados para el P^{32} , el Y^{81} , el Tl^{204} y el RaE en forma de curvas y tablas. El estudio revela que, en lo relativo al P^{32} y hasta distancias del orden de 0.5 mm. en agua, el índice de la dosis se conforma bastante bien a la ley de la razón inversa al cuadrado de la distancia; esto constituye una gran simplificación cuando hay que computar dosis integrales en sistemas biológicos de pequeñas dimensiones. Confirma además la opinión de que, cuando la concentración en un sistema varía rápidamente dentro de distancias mucho más cortas que el alcance de las partículas, la dosis se gobierna en lo principal por la concentración media del sistema.

DISCUSSION

Harold O. Wyckoff, Ph.D. (Washington, D. C.): The authors are to be congratulated on the research just reported. The need for the data has been pointed out by the essayist. In addition, however, this information will help to fill a gap in a pure physics field of the interaction of the electrons with matter. The technic of measuring the electron effects in a low density material is of extreme importance in extending the range of otherwise short range phenomena. Because of this extension, however, the scattering from objects will of necessity become more important. These workers have considered such effects and carefully eliminated them.

Rather than dwell on the experiment itself or its results, since the work has been clearly explained, I would prefer to ask about plans for possible extension of the technic for the determination of other important parameters and of a detailed understanding of the physical factors considered.

From the differences indicated at short distances by the two ionization chambers, it would appear that the atomic number may be important in some applications. Perhaps Dr. Clark is already antici-

pating doing some work along the line of extending this work to materials of other atomic numbers than air. I think it will be of interest to hear about his plans in that direction.

In addition, we now have methods which have been used for computing gamma ray interaction of matter which probably will be applicable to the interaction of electrons with matter. It would be interesting to know whether Dr. Clark plans on using these theories to investigate the complex phenomena involved. Perhaps he could tell us if he has plans for such tests.

Sergei Feitelberg, M.D. (New York): Loevinger, working in our laboratory, derived point source functions from measurements on a plane source. We were fortunate to receive from Dr. Clark his data on direct point source measurements early this year. In our opinion, the disagreements with Clark indicate that Loevinger's equations were not valid for lower beta energies at small distances from the source.

By introducing two separate absorption parameters, one for the radial electron component and another one for the scattered electrons, a second term

appears in the equation, which now fits both Loevinger's data from plane source measurements and Clark and Marinelli's direct observations on point sources for all investigated beta emitters.

Dr. Clark (closing): Dr. Loevinger is to be congratulated on having succeeded in developing a formula for the ionization distribution around a point source of beta radiation which agrees as closely

with experiment as it does. I think that this is a representation which is potentially very useful.

As far as Dr. Wyckoff's request for information as to our future plans is concerned, unfortunately I have to report that, because of shifts in the physical environment of the laboratory and the concomitant changes in the available space, we are not now in a position to continue the investigations along the lines reported here.



Three-Dimensional Body Forms for Use in Treatment Planning with the 23-Mev Betatron¹

L. L. HAAS, M.D.,² R. C. WAKERLIN, A.B.,³ and V. P. DESTRO³

THE WORK described herein represents an effort to develop three-dimensional forms to facilitate treatment of patients with the 23-Mev betatron in the University of Illinois College of Medicine. The following three factors are of prime importance in planning treatment with the betatron: (a) accurate tumor localization; (b) field selection; (c) dose calculation and determination. Descriptive anatomical and clinical tumor localization are not sufficient. Meticulous topical and geometrical determinations must be made in order to select adequate fields and to calculate depth dosage.

Topical localization and depth determination of a tumor are easy when direct physical measurement is possible. This is feasible, however, only in special cases. Otherwise the aid of various clinical procedures is required. These include roentgen examination, simple physical methods, special instrumental and surgical technics, etc. Only when for some reason the more accurate individual depth determination technics could not be employed have we used known topographic cross-sections. Since these represent average normal standards which differ frequently from specific individual relationships, they are definitely of second choice.

Data of localization acquired by any of the several methods are transmitted for further work-up of field selection and dose determination into graphic form. If the fields are arranged in one plane (two dimensionally) the cross section of the body is traced in this plane. When particularly exact field selection is indicated for dose calculations to special structures located in different planes (three dimensions), or when fields in more planes

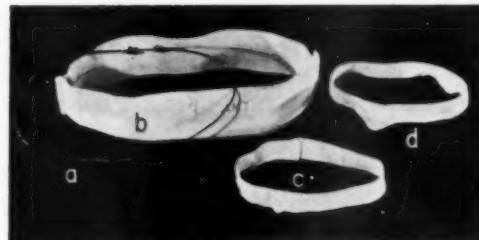


Fig. 1. a. Wire for tracing of body perimeter composed of two segments and connected by removable sleeves. b, c, and d. Gypsona plaster-of-Paris strips for chest, oropharyngeal area, and head.

are used, two or more tracings are required. This is true, for example, with many brain tumors.

The tracing procedure consists of two steps: (a) tracing of the body perimeter and (b) tracing inside of this the tumor area to be irradiated and the radiosensitive organs to be spared. In our experience, the plaster strip method for tracing the body contour has proved to be the most satisfactory. A thin strip of "Gypsona" bandage (see p. 108) 1/2 to 1 1/2 in. wide is fitted carefully over the body contour, without compression of the soft tissues. Whenever possible, one edge of the band should delineate the true perimeter at the desired level. Besides the accuracy and simplicity of this procedure, its advantage over the traditional wire methods is that the resulting band is permanent, can be checked later, and can be replaced on the body for identification of the entrance and exit points of the beam (Fig. 1b, c, and d).

The wire method is also practicable but requires great care, since removal and other handling may produce changes in shape. To minimize this risk, the wire is composed preferably of two or more segments connected by special sleeves

¹ From the University of Illinois College of Medicine, Chicago, Ill. Accepted for publication in November 1953.

² Associate Professor of Radiology, University of Illinois College of Medicine.

³ From the Department of Medical Illustration, University of Illinois College of Medicine.

which can be removed without changing their form (Fig. 1a). Any of several types of wire may be used, the choice being largely a matter of personal preference. Some wires are easily molded to conform to fine details of contour but are so pliable as to be very susceptible to accidental changes in form; others are less malleable and therefore hold their shape more easily. We experimented with wires of various aluminum, lead, and steel alloys but finally returned to solder wire of 1/16 in. thickness, preferably with a plastic resin core. Recently the draftsman's flexible curve is our choice, instead of wire, connected by special sleeves, particularly on large body parts. We prefer the use of plaster strips or the wire method to the frame with adjustable teeth for outlining contour as described by Martin (2). We should like to emphasize that all perimeter tracings should be checked carefully by caliper measurement of the sagittal and lateral diameters and of all distances between selected entrance and exit points of the various beam directions.

TECHNICS FOR MAKING THREE-DIMENSIONAL BODY MASKS

The wire method described above is satisfactory when the fields are arranged in one plane. When the fields are arranged in several planes (three dimensionally) it frequently becomes advisable to prepare either a complete or a partial mask of the body segment to be irradiated. Such molds or masks were found to be especially valuable in the early stages of our betatron therapy, when so many new problems were encountered concerning distribution of fields, location of entrance and exit points, determination of tumor depth and of depth dose in both tumor and healthy tissues, and positioning of the patient in the fixed horizontal beam.

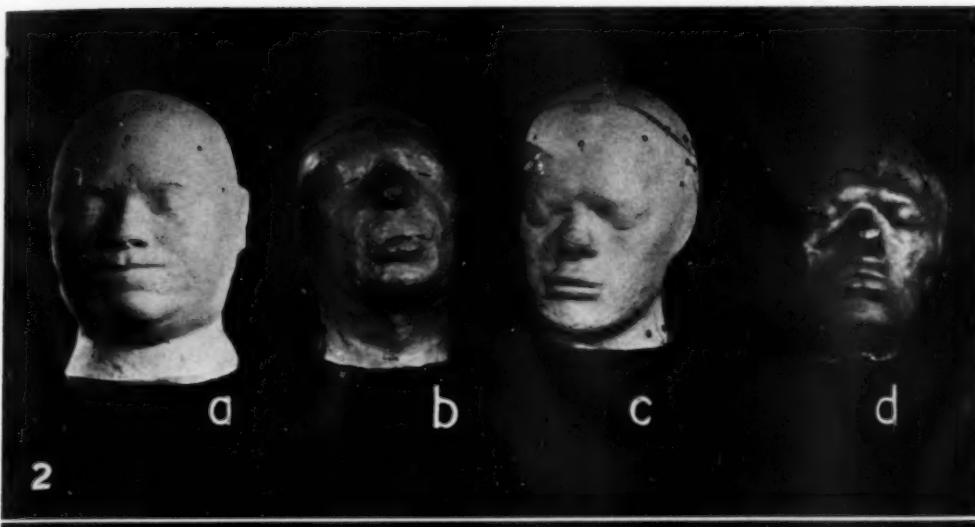
Our goal from the beginning was to prepare these body masks in such a manner that they could be replaced easily on the patient's body for positioning in the selected center beam, the exit and entrance

points being marked on the outer surface of the form. We wanted to find a thin, rigid material with which to make the masks and a technic for their preparation which would be rapid, inexpensive, direct, and as comfortable as possible for the patient.

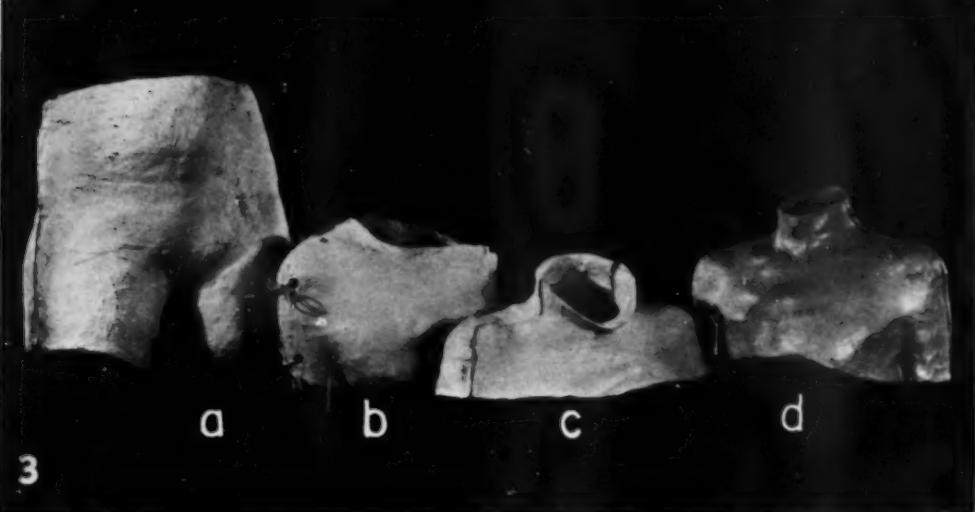
The first method tried was the conventional one used by artists, involving three stages: (a) a negative mold of plaster of Paris; (b) an intermediate cast of plaster (Fig. 2a); (c) a shell mold of papier mâché in several parts, hinged together for easy removal from the plaster form, and, later, from the patient's body (Figs. 2b and 3d). The results with this method were excellent, but there were several important disadvantages. The first of these was the long setting time for each of two or more pieces of the original plaster mold. This was unpleasant and very hard on the weaker patients. Secondly, the drying of the papier mâché shell on the cast was slow and the great amount of time required in its preparation and in pouring of the positive cast involved considerable expense.

A modification of this procedure consisted in replacing the plaster of Paris with plaster bandages as a mold material and cutting the hardened bandage from the patient's body (Fig. 3a). This was faster and, although the results were slightly less artistic, was a distinct improvement over the original technic. A further improvement was the change to the use of crinoline strips and wheat paste instead of papier mâché for the final shell mold (Fig. 2c). These molds of crinoline and paste dried faster than the paper shells and, once finished, were more pleasant for the patient for positioning.

We felt the need from the start to find a one-step process by which the first "negative" mold could be used directly as the final mask without intermediate steps. The solid plaster type of negative was not satisfactory for repositioning because of its weight and its rigid, awkward character for handling, nor did negatives made of conventional types of plaster



2



3

Fig. 2. a. Intermediate cast of plaster of Paris. b. Indirect shell mask of papier mache. c. Indirect shell mask of crinoline with wheat paste. d. Stockinet cloth impregnated with wax (courtesy of Singer Sewing Machine Co.). Mask prepared direct from face of patient.

Fig. 3. a and b. Direct mold of plaster-of-Paris bandage. c. Direct mold of Gypsona bandage. d. Indirect mold of papier mache.

bandage fully meet our requirements. Their surfaces were not sufficiently detailed and they were too clumsy for later positioning on the patient. While we did use the bandage negative method with some success for simple molds of the abdomen and lower chest (Fig. 3b), by and large it did not offer a solution to all of our problems and we continued to look for better.

Other materials which we investigated for use in making direct negative masks were: crinoline with wheat paste, a commercial product named "Celastic,"⁴ a wax impregnated stockinet cloth used by the Singer Sewing Machine Co. for dress-

⁴ Manufactured by the Celastic Corporation. This is a cotton fabric impregnated with a colloidal plastic. It becomes easily molded when soaked in "Celastic Softener" and hardens as it dries to conform to its molded form.

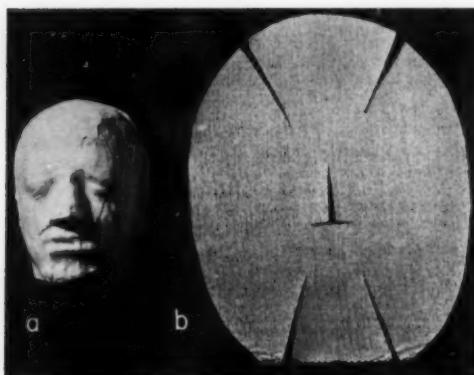


Fig. 4. a. Direct mask of Gypsona bandage. b. Preliminary cutting of Gypsona for head mask.

making manikins⁶ (Fig. 2d), and several others. Each had one or more serious disadvantages for our purpose and consequently had to be discarded. Among the disadvantages encountered were: slowness in drying and of the procedure as a whole, unpleasant odor, possible irritation of the skin by heat or chemical reagents, lack of detail in finished molds, complicated nature of technic, and stress for the patient. The Singer Sewing Machine Co. waxed cloth was quite satisfactory for large masks of the chest and abdomen but difficult to handle for molds of the head and face.

Finally we returned to plaster bandages, using a product which largely fulfills our requirements and lacks several of the disadvantages of other plaster bandages. "Gypsona" bandage, as the manufacturer states (3) ". . . is prepared from cellulose-compounded plaster of Paris The proportion of plaster to fabric is constant, and casts set firmly in less than ten minutes, presenting a hard, polished surface which does not crumble at the trimmed edges and is not readily soiled." Using this material, we have been able to produce shell molds directly on patients, having found that the setting is actually fast, the process reasonably comfortable for the

patient, and the cast durable, smooth, and properly rigid in thin layers (Fig. 3c). "Gypsona" can be applied easily to any contour with proper preliminary cutting of the dry material (Fig. 4b). The resulting direct mask is perhaps not as



Fig. 5. Partial mask of oropharyngeal area prepared directly on the patient, with Gypsona bandage. Note articulation of two pieces.

pleasing in appearance as the papier maché or crinoline shell made by the lengthy indirect method but is adequate for our needs. The shell is thin, 4 to 6 layers of bandage giving a mask of adequate rigidity. The setting time varies from four to ten minutes. Once set, the shell is carefully cut from the patient's body with a plaster cast cutter or with a pair of blunt-pointed bandage scissors. Head masks are formed in two halves, the edges of the first piece being greased well before application of the second. This allows a quick and simple separation. Registration marks should be used for refitting. Recently we have obtained similar results with "Melmac" resin plaster bandage (Davis & Geck, Inc.).

As our treatment planning has become more and more of a routine procedure, we have found that we have less and less need of these complete masks. Instead, we are satisfied with partial masks of smaller body segments, as for oropharyngeal lesions (Fig. 5), or with narrow

⁶ We wish gratefully to acknowledge the loan by the Singer Sewing Machine Co. of equipment for use of this material as well as the gift of sufficient plastic impregnated cloth to conduct our experiments in its use.

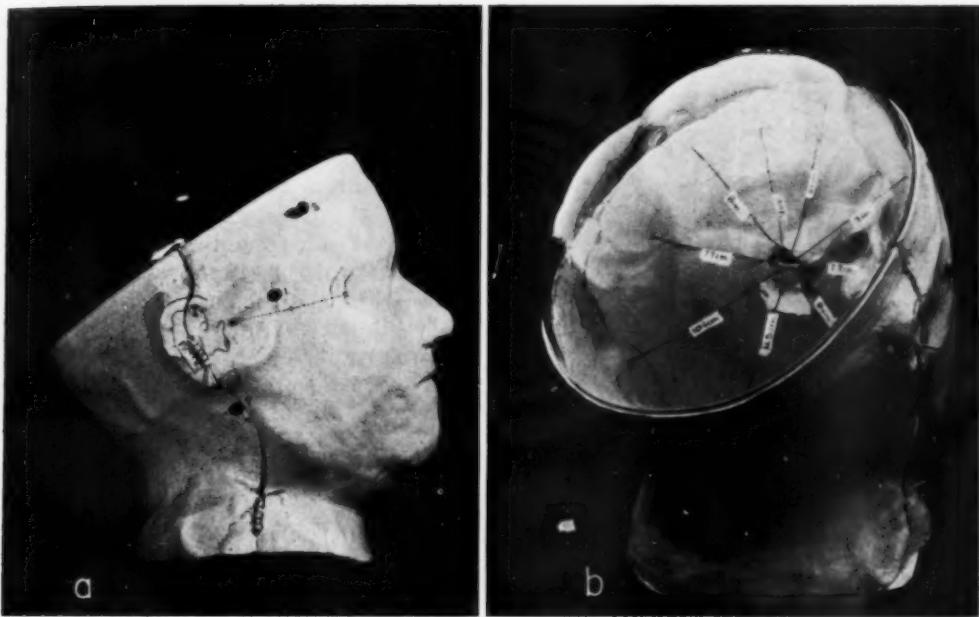


Fig. 6. Papier mâché mask with Lucite top to demonstrate beam directions and depths for calculation of tumor dose to pituitary. Entrance and exit points are marked with dots.

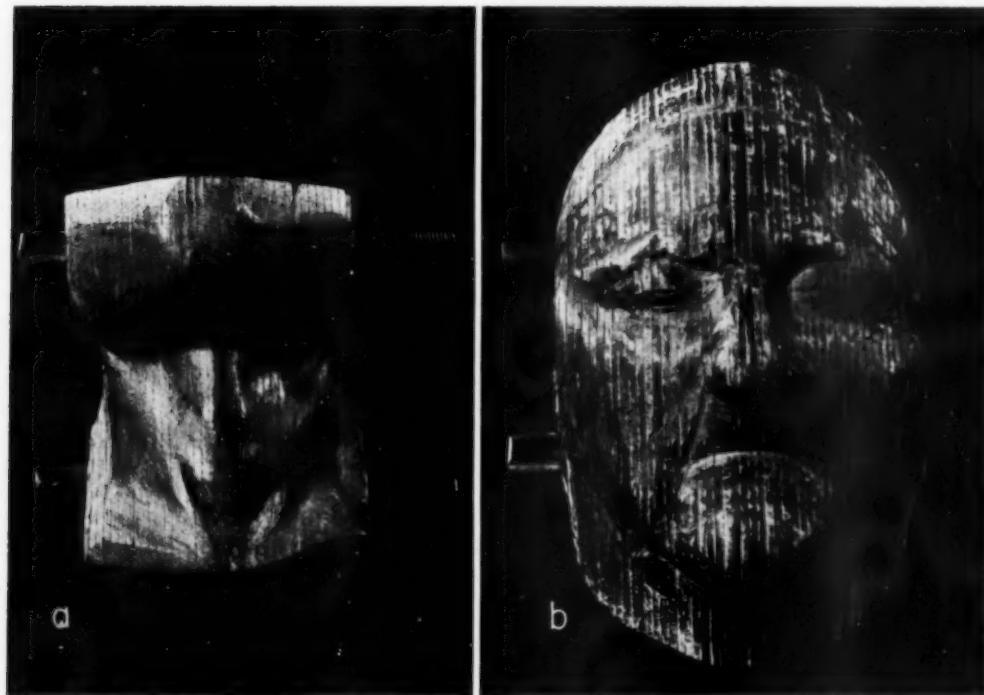


Fig. 7. Laminated Masonite phantoms of head and neck used for film density depth dose determinations.



Fig. 8. Laminated body phantom of Masonite.

"Gypsona" strips prepared in one or in multiple directions, as described above. In special cases, and for lesions in unusual locations, we still prepare complete masks as an integral part of our treatment planning procedure.

The preparation of transparent masks of "Plexiglas"⁶ or "Lucite"⁷ is possible with the aid of intermediate plaster casts but, as a routine procedure, is not practical due to the painstaking and expensive special work required. Fig. 6 shows two views of a papier mâché mask of the complete head in which a transparent Plexiglas calvarium is inserted. This special mask was prepared to demonstrate the principles of treatment planning by means of body masks. Wires represent the 9 selected beam directions focusing on the pituitary fossa, which is suspended in the

proper location inside the head. The length of the wires indicates the depths for determination of depth dosages.

Several other three-dimensional models were developed by our Illustration Studios in connection with the betatron experiments planned by Dr. J. S. Laughlin (1). Efforts have been made to replace the traditional water phantom for depth measurements with phantoms which have the same shape and dimension as the human body. Models of wax were first prepared, the wax having a density similar to that of water. However, the wax phantoms were not very satisfactory. More successful and useful were the phantoms (Fig. 7) made of serial sections of Masonite presdrwood, which has a density of 1.000. The head model shown in Figure 7b, made to conform to a cast of an individual patient, is fabricated of parallel Masonite sheets each 1/4 inch thick. It is fastened together with threaded bolts toolled of the same material. Films sandwiched between the sections were used for densitometric depth dose determinations.

Fig. 8 shows a torso composed of 1-inch thick Masonite sections pegged one to the other. It can be used for film densitometric dose measurements and in several spots has holes for the insertion of ionization chambers.

SUMMARY

Various technics have been described for preparation of rigid masks and body forms for use in treatment planning with the 23-Mev betatron in its experimental stages. Certain technics were discarded for reasons outlined. Direct molding of "Gypsona" or similar plaster bandages on the patient proved to be the simplest procedure for delineation of body perimeters and for preparation of head and other body masks. These forms are shown to be useful for treatment planning and also for replacement on the patient's body for localization and identification of the selected fields.

⁶ Manufactured by Rohm and Haas Co., Inc.

⁷ Manufactured by E. I. du Pont de Nemours, Inc.

808 South Wood St.
Chicago 12, Ill.

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SUMARIO

Modelos Tridimensionales del Cuerpo para Uso al Planear Tratamiento con el Betatrón de 23 Mev

Al planear tratamiento con el betatrón de 23 Mev, hay que ejecutar meticulosas determinaciones tópicas y geométricas a fin de escoger campos adecuados y de calcular la dosis a profundidad. En esos casos, la preparación de máscaras rígidas y de modelos del cuerpo resulta útil para dicho fin.

Se han ensayado varias técnicas para la preparación de esos modelos. Describense aquí las mismas, señalando sus ventajas y desventajas. El moldeado directo en el enfermo de enyesados "Gypsona" (fabricados de escayola compuesta-celulosa) ha

resultado ser el procedimiento más satisfactorio para la delineación de los perímetros del cuerpo y para la construcción de máscaras de la cabeza y modelos de otras partes del cuerpo. El tiempo que necesita el yeso para endurecer es breve, el procedimiento es razonablemente cómodo para el enfermo y el molde es duradero, liso y de la debida rigidez. Esos modelos se han mostrado útiles para planear el tratamiento y además para reponerlos en el cuerpo con mira a la localización e identificación de los campos de terapéutica más adelante.



EDITORIAL

Work in Progress

The prompt dissemination of information arising out of current scientific research is of importance not only to those carrying on such work but to all who are engaged in related investigations. This matter is of particular concern to *RADIOLOGY* in its efforts to keep its readers informed as to the progress being made both in clinical research and in the fields of Radiobiology, Radiochemistry, and Radiophysics.

The solution of the problem is not an easy one. The large number of submitted manuscripts and the consequent backlog of material awaiting publication has resulted in what must appear to be an unduly long interval between acceptance of a paper and its appearance in print. Articles of clinical significance by their very nature often require many pages of text and, though consultation between editor and author frequently results in notable condensation, this has not proved to be the final answer to the question.

The suggestion has been made from time to time that all material be published in abstract form. That such a course would be far from satisfactory is obvious. Under this plan not only would it be impossible for the reader to check the accuracy of the observations but there would be no room to include the innumerable details that influence the outcome of experimental work in one direction or another.

A more satisfactory method of insuring prompt publication of new and important work has been adopted by the *Physical Review*. This takes the form of Letters to the Editor, of such length that it is possible to publish a number in a relatively small space. The Editorial Staff of *RADIOLOGY*, after careful study of the situation, has decided upon a trial program of publication along similar lines. This plan provides for the institution of a section on Work in Progress, to include short reports of studies currently under way or only recently completed, putting on record the early results and serving as a guide to those interested in similar research. These reports will be strictly confined to those presenting new work or a new aspect of an older subject. Like the usual full length contributed papers they will be subject to review by the Editorial Advisory Board and the Publication Committee. They should be of such length that they will occupy the space of not over 600 words, including tables or possible illustrations.

The first group of such reports, published in this issue, consists of nine selected papers on physics, but future reports may be devoted to any subject of radiologic importance. If there is evidence of sufficient interest in this new undertaking it will be continued in the future as a permanent feature of *RADIOLOGY*.



WORK IN PROGRESS

A Cavity Ionization Theory Including the Effects of Energetic Secondary Electrons¹

L. V. SPENCER and FRANK H. ATTIX

The Bragg-Gray theory of cavity ionization (1, 2) as usually applied assumes that electrons of energy T traversing the cavity lose energy continuously at the rate $S_{\text{air}}(T)$, the stopping power in air, and in the wall at the rate $S_{\text{wall}}(T)$. Actually, however, not all of the inelastic collisions of an electron passing through matter result only in local dissipation of an infinitesimal amount of energy. Some large energy transfers occur, generating secondary electrons of appreciable range, and their relative probability increases with the atomic number of the stopping material.

These secondaries augment the low-energy region of the electron spectrum entering the cavity from the surrounding wall material. Long-range secondaries produced within the air may escape the cavity without producing much ionization, but for walls of high atomic number the influx of secondaries predominates and the net result is an increase in ionization within the cavity. This is formalized in the following schematization:

We assume that the energy transferred in a collision is dissipated on the spot if it does not exceed a cut-off value Δ , taken to be the electron energy necessary to span the cavity. Otherwise the energy is carried away by a secondary electron. Accordingly $S_{\text{air}}(T)$ is replaced with $S_{\text{air}}(T, \Delta)$, which includes only contributions smaller than Δ . Simultaneously, the flux of electrons from the wall, which is proportional to $1/S_{\text{wall}}(T)$ in the Bragg-Gray model (as usually interpreted), is raised to $R_{\text{wall}}(T_0, T)/S_{\text{wall}}(T)$ to take into account the flux of fast secondaries; the factor R has been evaluated elsewhere (3). Therefore, the effective stopping

power ratio (4) $\frac{1}{T_0} \int_0^{T_0} dT S_{\text{air}}(T)/S_{\text{wall}}(T)$ of the Bragg-Gray theory is replaced with

$$\frac{1}{T_0} \int_{\Delta}^{T_0} dT S_{\text{air}}(T, \Delta) R_{\text{wall}}(T_0, T)/S_{\text{wall}}(T)$$

This theory has been found to predict fairly well the rise in ionization per gram observed by Gray (2) as the air pressure was reduced in a small lead chamber. Comparison with experiments of Attix and DeLaVergne (5) is shown in Table I.

A detailed account of the new theory will soon be published elsewhere.

TABLE I: ENERGY DISSIPATED PER UNIT MASS IN AIR RELATIVE TO THE WALL MATERIAL

(The experimental results were obtained with a flat chamber having a 1 mm. air gap (at 1 atm.) between plates of various material irradiated by Co^{60} gamma rays. They are normalized to present theory for carbon.)

Element	Bragg-Gray*	Present Theory	Attix-DeLaVergne
Carbon	0.989	0.995	0.995
Aluminum	1.10	1.15	1.14
Copper	1.29	1.41	1.40
Tin	1.48	1.69	1.75
Lead	1.66	2.03	2.14

* As usually applied.

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¹ From the National Bureau of Standards. This work was supported by the U. S. Atomic Energy Commission.

Absolute Dose Measurement of Cobalt-60 Radiation¹

H. E. JOHNS, Ph.D., D. V. CORMACK, Ph.D., G. F. WHITMORE, M.A., and C. GARRETT, M.A.²

Recently it has been found that a Victoreen chamber correctly calibrated at 200 kv will not necessarily read correctly for cobalt-60 radiation. The correction to be applied has been determined by the National Research Council of Canada in Ottawa using a radium standard and assuming an emission constant of 8.4 r/hr./mg. at 1 cm. Correction factors ranging from 1.04 to 1.15 have been found for various Victoreen chambers. However, the method involves some uncertainties, since (a) very long exposures are required, (b) the stem effects are hard to determine accurately, and (c) the 8.4 figure is in some doubt.

In order to make an independent check of these correction factors, the output of the Saskatoon unit has been measured, using carbon chambers of known volume placed at 80 cm. from the source. The charge collected per minute has been measured absolutely as 24.1 e.s.u./min. per 0.001293 gm. of air. Assuming that the stopping power of air relative to carbon is 1.015 and that the absorption in the

front wall is 1.5 per cent, the output is 24.9 r/min. Three Victoreen chambers with their N.R.C. corrections gave measured outputs of 24.2, 24.5, and 24.6 r/min. These are in reasonable agreement with the carbon chamber results.

¹ From the Department of Physics, University of Saskatchewan and the Saskatchewan Cancer Commission.

² Of the National Research Council of Canada.

Broad Beam Attenuation of 70-250 Kv.p. X-Ray Beams in Aluminum

E. DALE TROUT, Sc.D., JOHN P. KELLEY, B.S., ARTHUR C. LUCAS, B.S., and EDWARD J. FURNO, B.S.

The necessity of using broad beam attenuation data for planning x-ray protection has already been pointed out (1). Beams at least 3 feet in diameter at the barrier must be employed if useful data are to be obtained. For studies of the attenuation of low-voltage beams, it is difficult to make and handle large, thin sheets of concrete. Miller and Kennedy (2) recently called attention to the fact that since attenuation of such beams in materials of low atomic number is due to Compton effect, attenuation data can be taken in other material of low atomic number (viz. aluminum), and by applying a small correction factor use can be made of these data in computing the required concrete barrier thickness. This correction factor, 1.1, remains constant over a very wide range of voltages.

The attenuation of x-ray beams produced by pulsating voltages of 70, 100, 125, 150, 200, and 250 kv.p. has been measured in commercially pure aluminum. The thickness of concrete required can be computed by multiplying by 1.1 the thickness of aluminum necessary for the required attenuation,

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A Phantom for Physical Studies in Chest Radiography¹

H. R. SPLETTSTOSSER, B.S., and H. E. SEEMANN, Ph.D.

Phantoms containing various graded test objects have been described in the literature (1-3) and have the obvious advantage that the value of changes in radiographic technic can be assessed in a more or less quantitative manner. Radiographs of such test objects have no resemblance, however, to radiographs of any part of the body and therefore may not appeal as much to the radiologist as something more closely resembling a medical radiograph.

For our chest phantom, we began with an actual skeleton of the human chest as a basis. Nylon

fibers were used to hold loose parts together and a 3/8-inch Lucite rod was suitably bent and run through the vertebral foramina to keep the vertebrae in natural alignment. This rod is not visible in radiographs of the phantom. The outline of a heart was obtained from chest radiographs; then the "heart" itself was formed from layers of Masonite preswood and rounded smoothly. (The present heart is not quite thick enough.)

"Lungs" were prepared by soaking natural sponges in Casco glue and then squeezing out some of the absorbed glue. Sponges alone are much too radioparent; saturated with glue they are too radiopaque. When dry, the glue-impregnated sponges were cut to the desired shape. The vacant regions in the chest cavity were packed firmly with cotton to help maintain the parts in position rather than to obtain x-ray absorption.

"Tissue" outside the rib cage was simulated with polyethylene plastic. This was applied in the form of tape, which was wound on until a suitable thickness was obtained.

X-ray exposures were made in the course of construction to check the radiographic appearance of the phantom. On its completion, it was found that there was insufficient absorption in the mediastinum and near the periphery. This was corrected by adding bevelled strips of wood to the outside. These do not show, as such, in the radiographs. Scattered radiation from this phantom is a little greater than from an average actual chest in the living subject.

We have used this phantom in studies of subject contrast. Some of these radiographs were shown in the Scientific Exhibit at the meeting of the Radiological Society of North America, Los Angeles, Dec. 5-10, 1954.

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¹ From the Research Laboratories of The Eastman Kodak Co., Rochester, N. Y.

Dose to Walls in Radiographic Rooms¹

SCOTT W. SMITH, Ph.D., and ROBT. J. KENNEDY, Ph. B.

There are a number of factors involved in the computation of protective barriers for medical installations which are difficult to evaluate. This is due in part to insufficient data concerning some of them and to the variable nature of others. Thus, to assure an adequate degree of safety, it has been the

TABLE I: DOSE TO WALLS IN RADIOGRAPHIC ROOMS

Installation	ma-min./week Radiography	ma-min./week Fluoroscopy	Chamber Height	mr/week Avg.	mr/week Max.	mr/1,000 ma-min.* Avg.	mr/1,000 ma-min.* Max.
Radiologist: A	562	268	4'	328	518	600	920
Radiologist: B	523	305	4'	240	644	460	1230
Clinic: Room 1	292	54	4'	214	447	730	1530
Clinic: Room 2	462	..	4'	400	600	870	1300
Hospital: A	223	..	4'	60	140	270	630
Hospital: B	348	..	4'	66	265	190	760
Hospital: C	763	..	4'	100	216	130	280
Dental Clinic	320	..	4'	154	235	480	740

* Based on radiography only.

practice in computing barriers to assume near-maximum exposure conditions for both the useful beam and stray radiations. This procedure is definitely safe, but the question arises as to whether it is realistic.

The survey with which this report is concerned was intended to determine the radiation actually reaching the walls of radiographic rooms in a number of installations, and to gain from this some notion of the safety factor which currently exists in computing the barriers. This study should be considered as preliminary, since only a small number of installations were studied, although they included three hospitals, a radiological clinic, and two offices of radiologists.

In each case, small ionization chambers were attached to the walls of the rooms at the floor level, at a height of 7 feet, and at a point between. The chambers were read daily for about a week, and a record was kept of the individual radiographic exposures. The data thus obtained permit calculation of the average dose to the walls in mr per 1,000 ma-min. Table I lists the values at 4 feet, the height of maximum dose.

The data indicate that the maximum dose to the walls is about two or three times the permissible dose rate of 300 mr/week. The highest values shown are in most instances at positions immediately adjacent to cassette changers and may be due to improper coning of the beam.

It would appear from these tentative data that from one to three half-value layers of protective material may be sufficient for radiographic rooms, with a work load of 1,000 ma-min./week instead of about ten, as currently required.

¹ From the National Bureau of Standards. This work was partially supported by the U. S. Atomic Energy Commission.

Integral Dose Measurements Preliminary Report on a Co⁶⁰ Teletherapy Beam¹

L. D. MacDONALD,² R. L. HAYES, and M. BRUCER

A study of the integral dose relationships involved in Co⁶⁰ teletherapy has been made by means of

phantom technics and aqueous chemical dosimetry. This method is readily adapted to the solution of integral dose problems. The percentage of total "torso" phantom dose received by centrally located phantom "tumors" was studied with respect to distance from the source and the size of the "tumor."

Fricke's aerated aqueous ferric sulfate dosimeter system (1), which is based on the oxidation of Fe(II) to Fe(III) by the indirect action of ionizing radiation on water, was used in all measurements. The total chemical yield in this system is proportional to the energy absorbed, independent of the photon energy in the Co⁶⁰ energy region, and independent of the Fe(II) concentration within wide limits.

The torso phantom used was a cylindrical Pyrex glass tank having a 24-cm. inside diameter. Tumor phantoms were spherical Pyrex flasks sealed to 1.1-cm. Pyrex tubing, with which they were positioned in the torso phantom. Measurements were made with the torso phantom filled with dosimeter solution to a constant height of 30 cm., with the tumor phantom in position. Preliminary measurements had indicated that the difference between the total phantom doses at heights of 25 and 30 cm. was less than the experimental error of the method. The tumor phantoms were centered both horizontally and vertically in the "torso" dosimeter solution and were themselves filled with dosimeter solution to a level that nearly approximated a perfect sphere. In all experiments, the diameter and taper of the beam collimating cone used, and the distance at which the assembled phantom was positioned with respect to the central axis of the tumor phantom, were such that the area of the geometric field of the Co⁶⁰ beam just covered the outer glass circumference of the tumor phantom. Adjustments of the focus of the Co⁶⁰ beam on the tumor phantoms were made in all instances with the aid of a light localizer that had previously been proved by x-ray film exposures. After "treatment" of the assembled and positioned phantom, the solution in each compartment was thoroughly mixed, and the amount of Fe(III) produced per unit volume by the exposure was determined spectrophotometrically. From a knowledge of the volume content of each compartment, the total energy absorbed in each compartment could then be calculated.

This study was meant to mimic the integral dose relations involved in simple rotational therapy. It is planned to expand investigations with aqueous chemical dosimeters to studies of integral dose from brachytherapy sources and teletherapy beams. Different photon energies will be studied as will stationary, rotational, and moving fields.

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¹ From the Medical Division, Oak Ridge Institute of Nuclear Studies, Inc., Oak Ridge, Tenn., under contract with U. S. Atomic Energy Commission.

² Work done while a summer participant with the Oak Ridge Institute of Nuclear Studies, University Relations Division. Present address: University of Mississippi, University, Miss.

Measurement in Vivo of Radium Gamma-Ray Activities Lower than K^{40} Levels Existing in the Human Body¹

L. D. MARINELLI, M.A., C. E. MILLER, Ph.D.,
R. E. ROWLAND, M.S., and J. E. ROSE

The measurement of gamma rays emitted by more than about 0.03 μ g of Ra in the human skeleton can be carried out conveniently with moderate shielding ($\sim 1/4$ in. Pb) and easily available NaI crystals ($2\frac{1}{4} \times 1\frac{1}{2}$ in.) by comparing the counting rates engendered by suitably located persons with positive and negative radium exposure history. The error due to the difference in body potassium content (~ 0.012 gamma ray μ c) is small, if care is taken to match body weights. Below this level of burden, the task is made progressively more difficult by the stricter requirements of high intrinsic sensitivity, low environmental gamma-ray background and interference from potassium activity and cosmic rays. In our laboratory, crystals of NaI (1.5×1 in., 4.2×1.5 in.), CsI (1.5×1 in.), and a large plastic scintillator (6×5 in.) have been housed in a room $7 \times 7 \times 8$ ft., shielded by 8 inches Fe.

Their scintillation pulses have been analyzed in the presence of background Ra and K sources under a variety of conditions in order to explore soundness and economics of detector design.

Ra body content can be determined by detection of 1.5 to 2.5 Mev pulses—to exclude all interference from K^{40} —with a standard deviation of $\pm 1.4 \times 10^{-3} \mu$ c when the large NaI crystal is used for an observational period of two hours. Results obtained with the small NaI and CsI crystals suggest that this limit cannot be reduced substantially by use of the latter and that approach along these lines is apt to be prohibitively expensive. A more promising method—capable of yielding in a two-hour reading a standard deviation of $\pm 3.4 \times 10^{-4} \mu$ c in the measurement of radium and 4.8 gm. in the measurement of potassium—is obtained by the simul-

taneous recording of pulses generated in the plastic and large NaI scintillators, provided they are suitably selected in each for maximum relative sensitivity to K and Ra respectively.

Although preliminary experiments suggest that modest additional Hg shielding and cosmic ray coincidence techniques can substantially reduce the background counting rate, it seems at this time that the intrinsic radioactivity of the detector itself represents the major obstacle to the attainment of fluctuations of the order of one-tenth of those hitherto considered. In order to attain practical sensitivities, the detector and its housing must be bulky—to intercept a significant fraction of the few gammas emitted by the human body—and must, at the same time, possess a total radioactivity lower than 10^{-12} c .

¹ From the Radiological Physics Division, Argonne National Laboratory, Lemont, Ill. Based on work performed under the auspices of the U. S. Atomic Energy Commission.

Assay of P^{32} by Bremsstrahlung Counting with a Well-Type Scintillation Crystal¹

ROBERT LOEVINGER, Ph.D., and SERGEI FEITELBERG, M.D.

A standard method of determining blood volumes is by isotopic dilution, with the use of red cells tagged with P^{32} . A time-consuming part of the procedure is preparation of the blood samples for counting on a Geiger tube sensitive to β particles. The method used at our institution has been to pipette 0.2 c.c. of the heparinized blood on squares of blotting paper backed by aluminum foil, which are then covered with plastic sheet about 2 mg./cm.^2 thick. The unit thus prepared is wrapped in a cylinder and slipped over a Geiger tube with a thin anode wall (30 mg./cm.²).

It is possible to count the P^{32} in aqueous solution, or in heparinized whole blood, simply by putting it in a Pyrex test tube, which is lowered into a well-type scintillation crystal. Comparison of the two methods is as follows:

	Well-Type Crystal	Wrap- Around
Volume used (c.c.)	5	0.2
Background (counts per second)	4	0.6
Counts per second per μ c	3×10^3	7×10^3
Counts per second per μ c/c.c.	1×10^3	1×10^3

The tracer level presently administered (25–50 μ c) gives a blood activity of about $7 \times 10^{-3} \mu$ c/c.c. At this specific activity the counting time required to reach a given per cent accuracy is essentially the same for the two methods, due to the larger volume useful with the well-type crystal. The counting procedure is greatly simplified by using the scintillation crystal.

Absorption curves have been made by wrapping plastic test tubes with lead foil. Comparison of absorption curves made with thin-walled (about 1 mm.) and thick-walled (about 6 mm.) test tubes indicates that about 80 to 85 per cent of the counts are due to bremsstrahlung, the remainder being due to $P^{32}\beta$ particles reaching the crystal. The standard deviation of a single activity determination was estimated by counting an aqueous solution of P^{32} in a series of unselected test tubes. It was found to be 3 per cent in one run of 10 samples, and 1 per cent in a second run of 10 samples, exclusive of statistical counting errors.

Presumably the bremsstrahlung arising from an aqueous solution of P^{32} is primarily the so-called "inner-bremsstrahlung." The yield of "outer bremsstrahlung" can be increased by inserting a suitably shaped piece of metallic lead in the test tube at the time of counting, or by adding a concentrated solution of a lead salt. The resulting increase in counting rate is at most around 40 per cent.

¹ From the Andre Meyer Department of Physics, The Mount Sinai Hospital, New York, N. Y.

Design and Initial Operation of a 50-Mev Microwave Linear Accelerator for Electron Beam Therapy

LESTER S. SKAGGS, Ph.D.,¹ JOHN C. NYGARD, B.S.,² and LAWRENCE H. LANZL, Ph.D.¹

A number of basic requirements for an accelerator for electron beam therapy were laid down by the Argonne Cancer Research Hospital in its contract with the High Voltage Engineering Corporation. These included: full output at 50 Mev; control of electron energy output from 10 to 50 Mev without appreciable change in output current, beam cross section, or spectral distribution; total output of 1/10 microampere; high order of operational reliability.

These were achieved with an accelerator consisting of two 8-ft. sections of waveguide of the Stanford type (fabricated by Stanford University) operated in cascade. Each section is driven by a separate 20-megawatt klystron (also fabricated by Stanford). The two klystrons are driven by a single magnetron with variable phase delay in the drive to one of the klystrons. A single knob on the control stand adjusts the phase delay, giving a smooth and continuous control of energy through control of the phase of the electrons with respect to the radio-frequency wave in the second section of the waveguide. Since the conditions of injection are not altered when the electron energy is changed, the character of the output beam is not modified appreciably. The klystrons are pulsed on at full power for a period of 1.6 microseconds repeated 60 times per second. Injection of electrons is at 100 kv for a period of 0.6 microseconds with the injector pulse delayed 0.9 microseconds from the start of the klystron pulse to allow the waveguide to be filled with radiofrequency energy. The injector uses a tantalum filament with grid control and combined electrostatic and magnetic focusing. Operational reliability is increased through the provision of a third klystron in stand-by condition that can replace one that has failed through a simple change in waveguide and coaxial line connections; through the use of D-C resonant charging of the klystron pulse lines; through the use of high-speed vacuum pumps with adequate high-vacuum valving; and through conservative design that does not place excessive load on high-voltage and high-power components. The machine operates satisfactorily to 50 Mev, and indications are that the output could be extended safely to 60 Mev.

¹ Argonne Cancer Research Hospital, The University of Chicago, Chicago, Illinois.

² High Voltage Engineering Corporation, Cambridge, Massachusetts.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN COLLEGE OF RADIOLOGY

Dr. Wilbur Bailey of Los Angeles has been elected Chairman of the Board of Chancellors of the American College of Radiology, to take office in February 1955, succeeding Dr. Ira H. Lockwood.

DR. IRA H. LOCKWOOD AWARDED GOLD MEDAL OF THE AMERICAN COLLEGE OF RADIOLOGY

Dr. Ira H. Lockwood, of Kansas City, Mo., has been awarded the Gold Medal of the American College of Radiology. The award will be formally presented, Feb. 11, 1955, at the Annual Meeting of the College in Chicago, following which Dr. Lockwood retires as the Chairman of the Board of Chancellors, the official governing body of the College.

During the thirty-year history of the College of Radiology, only 12 other persons have been awarded the Gold Medal. The award is based upon "... distinguished and extraordinary service to the American College of Radiology and to the profession for which it stands."

NORTH DAKOTA RADIOLOGICAL SOCIETY

At the last meeting of the North Dakota Radiological Society, the following officers were elected: President, Dr. Phil R. Berger, Grand Forks; Vice-President, Dr. Johan A. Eriksen, Bismarck; Treasurer, Dr. H. Milton Berg, Bismarck; Secretary, Dr. Marianne Wallis, St. Joseph's Hospital, Minot.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Recently elected officers of the San Francisco Radiological Society are: Charles S. Capp, M.D., President; Ivan J. Miller, M.D., President-Elect; Joseph Levitin, M.D., and Earl R. Miller, M.D., members of the Executive Committee; Tom M. Fullenlove, M.D., 110 El Verano Way, San Francisco 27, Secretary-Treasurer.

MID-WINTER RADIOLOGICAL CONFERENCE

The Seventh Annual Mid-Winter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Ambassador Hotel in Los Angeles, Calif., on Saturday and Sunday, Feb. 26 and 27, 1955.

The following speakers will present papers on the subjects listed: Prof. Olle Olsson, Lund, Sweden: Renal Angiography; Tolerance to Contrast Media. Paul C. Hodges, M.D., Chicago, Ill.: Neoplasms of Bone; Fibrous Dysplasia of Bone. Simeon Cantril,

M.D., Seattle, Wash.: Hodgkin's Disease; Palliation and Care of Terminal Patients. Leslie Bennett, M.D., Los Angeles: Medical Isotopes. George Jacobson, M.D., Los Angeles: Value of the Postero-anterior Chest Film in Cardiac Radiology. Ross Golden, M.D., Los Angeles: Tumors of the Small Intestine; Physical Problems in Detection of Cancer of the Stomach. Charles E. Grayson, M.D., Sacramento, Calif.: The Pulmonary Cripple.

Informal round-table luncheons with the guest speakers will be featured both days, with the cost of the luncheons included in the Conference fee of \$20.00. An additional charge of \$6.50 per person will be made for the banquet on Saturday evening, February 26. Residents in radiology and radiologists in active military service will be admitted to the scientific sessions of the conference without payment of registration fee.

Conference reservations may be made through the chairman, Richard A. Kredel, M.D., 65 North Madison Ave., Pasadena, Calif. Checks should be made payable to Mid-Winter Radiological Conference. Hotel reservations should be made as soon as possible through the Convention Manager of the Ambassador Hotel.

A COURSE IN THE CLINICAL USE OF RADIOACTIVE ISOTOPES

A course in the clinical use of radioactive isotopes will be given by Dr. Sergei Feitelberg of Mount Sinai Hospital, New York, and Dr. Edith H. Quimby of Columbia University, May 30 to June 24, 1955, Mondays through Fridays, 9 to 12 A.M. and 1 to 5 P.M.

This is a full-time course, including lectures, clinical rounds, and experimental laboratory exercises, as well as clinical laboratory measurements on patients and on specimens. In addition to the listed instructors, sixteen invited lecturers from the New York area will present topics in their special fields.

The lectures will cover the physics of radioactive isotopes and of interaction of radiation and matter; technic and measurements of radiation and of radioactive isotopes; the clinical use of radioactive iodine in thyroid disease, the therapeutic use of radioactive phosphorus and radioactive gold; the diagnostic use of miscellaneous isotopes (determination of blood volume, localization of brain tumors, radioactive sodium, and radioactive iron); and the organization of radioisotope work in a hospital.

Laboratory work will comprise thirteen afternoon sessions devoted to experiments on basic methods of radioisotope measurements, on techniques used in clinical diagnostic work, and experience with equipment actually used in clinical procedures.

The class is limited to twelve; the fee for the course is \$200. Inquiries may be addressed to Dr. Edith H. Quimby, Radiological Research Laboratory, 630 West 168th St., New York 32.

In Memoriam

JOHN LLOYD TABB, JR., M.D.

Dr. John Lloyd Tabb, Jr., of Richmond Va., a member of the Radiological Society of North America since 1922, died Sept. 1, after a brief illness, at the age of sixty-one. Dr. Tabb was born in Gloucester County, Va., and was graduated from the Medical College of Virginia in 1916, following which he served in France during World War I. He was chief radiologist at St. Luke's Hospital, Richmond, where he had been a member of the staff since 1924, roentgenologist to the Crippled Children's Hospital, and Associate Professor of Radiology at the Medical College of Virginia. He was a member of many professional organizations and a past president of the Radiological Society of Virginia.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

THE YEAR BOOK OF RADIOLoGY (1954-55 YEAR BOOK SERIES). RADIOLoGIC DIAGNOSIS, Edited by JOHN FLOYD HOLT, M.D., Associate Professor, Department of Roentgenology, University of Michigan, and FRED JENNER HODGES, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan. **RADIATION THERAPY**, Edited by HAROLD W. JACOX, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City, and VINCENT P. COLLINS, M.D., Professor and Chairman, Department of Radiology, Baylor University, College of Medicine; Radiologist-in-chief, Jefferson Davis Hospital, Houston, Texas. A volume of 432 pages, with 348 illustrations. Published by The Year Book Publishers, Inc., 200 East Illinois Street, Chicago, Ill. Price \$9.00.

DIE WIRBELSÄULEN-VERLETZUNGEN UND IHRE AUSHEILUNG. PATHOLOGISCHE ANATOMIE, KLINIK, RÖNTGENDIAGNOSTIK BEGUTACHTUNGS- UND ZUSAMMENHANGSFRAGEN. By PROF. DR. MED. ALFONS LOB, Sanderbusch i. Oldenburg. Second revised edition. A volume of 272 pages, with 340 illustrations and 16 tables. Published

by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by Intercontinental Medical Book Corp., 381 Fourth Ave., New York. Price DM 78.—(\$18.55).

LEHRBUCH DER RÖNTGENOLOGISCHEN DIFFERENTIALDIAGNOSTIK. VOLUME II: ERKRANKUNGEN DER BAUCHORGANE. By WERNER TESCHENDORF, Köln. Third improved and enlarged edition. A volume of 1,038 pages, with 1,610 illustrations. Published by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., 381 Fourth Ave., New York. Price DM 186.—(\$44.30).

RÖNTGENDIAGNOSTIK DES SCHÄDELS. By PROF. DR. WILLY LOEPP, weil. a. o. Prof. für Röntgenologie an der Universität Königsberg (Pr.), and PROF. DR. REINHOLD LORENZ, Apl. Prof. an der Universität Hamburg; Chefarzt des Röntgeninstituts des Krankenhauses, Hamburg-Barmbek. A volume of 580 pages, with 696 illustrations. Published by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., 381 Fourth Ave., New York. Price DM 97.—

LEHRBUCH DER TUBERKULOSE DES KINDES UND DES JUGENDLICHEN. By PROF. DR. MED. WERNER CATEL, Direktor der Universitäts-Kinderklinik, Kiel. Second completely revised edition. A volume of 502 pages, with 148 illustrations including some in color. Published by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., 381 Fourth Ave., New York. Price DM 66.—

LUCHA CONTRA EL CÁNCER. CINCUENTA AÑOS DE MORTALIDAD Y MORBILIDAD CÁNCEROSA ESPAÑOLA. By PROFESSOR DR. ANTONIO LLOMBART, Catedrático de Histología, Anatomía Patológica y Cancerología de la Facultad de Medicina de Valencia; miembro del Consejo Superior de Investigaciones Científicas y del Instituto Radio-Quirúrgico de Guipúzcoa; and UBALDO GASTAMINZA, Jefe del Servicio de Anatomía Patológica del Hospital de San Antonio Abad, de San Sebastián, y del Instituto Radio-Quirúrgico de Guipúzcoa. A volume of 190 pages, with numerous graphs and tables. Published by Instituto Radio-Quirúrgico de Guipúzcoa, 1954.

XII^o CONFERENCE DE L'UNION INTERNATIONALE CONTRE LA TUBERCULOSE, held at Rio de Janeiro, Brazil, Aug. 24-27, 1952. A volume of 722 pages, with numerous illustrations including roentgeno-

grams, graphs, and tables. Published by the Fédération Brésilienne des Sociétés de Tuberculose, Rio de Janeiro, Brésil.

Book Reviews

THE AUXILIARY HEART. By WILLIAM WALTER WASSON, M.D. A volume of 186 pages, with numerous illustrations including roentgenograms, photomicrographs, schematic drawings, and tables. Published by Charles C Thomas, Springfield, Ill., 1954. Price \$10.50.

This small but important volume is concerned with the combined bodily forces that aid the heart in propelling the blood through the body. The author confines his discussion for the most part to the lesser circulation. Because the lungs play such a vital role here, considerable space is devoted to processes of respiration.

The early chapters have to do with the anatomy, the physiology, and the physiodynamics of the lungs as they are concerned with the lesser circulation. The author then turns to the roentgen study and discusses the technical factors necessary to produce a satisfactory film. He divides the diseases which influence the auxiliary heart into four groups: (1) diseases of the heart; (2) diseases of the pulmonary arteries, capillaries, and veins; (3) diseases of the lungs; (4) diseases of the thorax and general state of the patient. The diaphragmatic syndrome is then discussed, and the great influence of the diaphragm on the lesser circulation is pointed out. All of these chapters are amply illustrated with roentgenograms, schematic drawings, and photographs.

Following the main body of the work is an "Historical Sketch" by Mindell W. Stein, who details the scientific work which has resulted in our present knowledge of the subject. An extensive bibliography is furnished.

This volume is a valuable and interesting study of the little appreciated forces which aid and interfere with the right heart and the lesser circulation.

ATLAS POSTMORTALER ANGIOGRAMME. By DR. J. SCHOENMACKERS, Apl. Professor für pathologische Anatomie, and DR. H. VIETEN, Dozent für medizinische Strahlenkunde. A volume containing 204 pages, with 131 illustrations including 14 schematic sketches. Published by Georg Thieme, Stuttgart, 1954. Distributors for the United States and Canada, Intercontinental Medical Book Corporation, 381 Fourth Avenue, New York. Price DM 57.—(\$13.55).

This remarkable and beautiful work is an atlas of postmortem angiograms of the several systems and organs of the body. As the authors state, the increasing use of angiography as a clinical diagnostic method and the development of vascular surgery make such a comparative pathologic-anatomic

study necessary, in order to put clinical diagnosis upon a firmer pathologic foundation. Such a work also gives information relative to diseases which rarely or never come to angiography, or in which angiography is contraindicated. Further, it supplements our classic pathologic anatomy in that it allows clear portrayal of an abnormal vascular pattern which often cannot be determined with routine technics. In this respect, postmortem angiograms when viewed stereoscopically are without equal.

In the first or general section of this book one finds a discussion of the technic employed, the limitations of the method, and general remarks on the characteristics of the blood stream, with the causes for vascular changes. In the larger second part, one finds the actual angiograms grouped under the following headings: lungs, brain, heart, kidneys, trunk, fetus, portal system, and veins of the greater circulation. The illustrations include both the normal and a wide variety of pathologic states. With each illustration are given the pathologic-anatomic diagnosis, a description of the postmortem angiogram, and its interpretation.

With the increasingly greater use of clinical angiography, there will be an ever increasing need for this work. Especially valuable for the person who does not read German are the excellent detailed summaries in English, French and Spanish after the discussion of each system.

The quality of the reproduction of the roentgenograms and the printing and binding are excellent.

ENCYCLOPÉDIE ÉLECTRO-RADIOLOGIQUE: RADIO-DIAGNOSTIC, TOME IV. TUBE DIGESTIF-FOIE-RATE-PANCREAS. Published under the Direction of ROBERT COLIEZ, Médecin Electroradiologue des Hôpitaux de Paris. A loose-leaf volume of the Encyclopédie Médico-Chirurgicale, with a large number of roentgenograms and drawings. Printed in France, 18, rue de Seguier, Paris, 6^e, 1954.

This volume, one of a monumental encyclopedia encompassing all the medical specialties and the fourth on Radiodiagnosis, is devoted for the most part to the digestive tract. The salivary glands, pharynx, esophagus, stomach, duodenum, small intestine, colon, liver, biliary tract, pancreas, and spleen are discussed from the standpoints of anatomy, the technic of radiologic examination, the various diseases to which they are subject, and the fine points of radiologic interpretation. Most of the newer refinements of examination and diagnosis are described. Radiographic illustrations are numerous and well chosen, and many explanatory pen and ink sketches serve to bring out certain points in a schematic manner. The list of contributors includes some dozen names familiar in French medicine.

The work is published in loose-leaf form, and the

typography and make-up are attractive. It is an important addition to the radiologic literature, which will, of course, be especially rewarding to those who read French.

BASES DE L'INTERPRETATION RADIOLOGIQUE. RADIOGEOGRAPHIE. By MANOEL DE ABREU, Professeur à la Faculté des Sciences Médicales de Rio de Janeiro. Published in two volumes, volume I containing 214 pages of text and volume 2 containing 683 illustrations. Published by Masson et Cie, Editeurs, 120, Boulevard Saint-Germain, Paris, 1954. Price 5,000 fr.

The author of this work is well known as a pioneer in photofluorography and is also recognized for demonstrating the principle of simultaneous tomography. Since his first publication on thoracic densities in 1919, he has been interested in the geometric principles which affect densities on the roentgenogram. He attempts here to analyze the effects

of lines and plane and curved surfaces of various geometric design, and then to correlate these principles with anatomic densities as seen by the roentgenologist.

The first volume consists entirely of text, while the second is an atlas of diagrammatic sketches and roentgenograms. Under the heading "Theorems of Radiogeometry," the effects of planes, triangles, superimposed angles, successive planes of contrast, curved surfaces, and other geometric contours are analyzed. These are then translated into practical roentgenographic contours of various organs and systems as seen in health and disease. Experimental procedures utilizing these principles in roentgenography of various parts of the body are described and illustrated.

For those who read French and have an interest in geometry as it may be applied to the analysis of roentgenographic densities, this work will be of definite interest. The sketched figures are well conceived and the roentgenographic reproductions are excellent.



RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Robert E. Fricke, M.D., Mayo Clinic, Rochester, Minn.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago 37.

Alabama

ALABAMA RADILOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADILOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 507 Professional Bldg., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADILOGICAL SOCIETY. *Secretary*, Joe A. Norton, M.D., 843 Donaghey Bldg., Little Rock. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, H. R. Morris, M.D., 1027 D St., San Bernardino.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADILOGICAL SOCIETY. *Secretary*, Oscar Harvey, M.D., 3741 Stocker St., Los Angeles 8. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADILOGICAL CLUB. *Secretary*, H. B. Stewart, Jr., M.D., 2920 Capitol Ave., Sacramento. Meets last Monday of each month, September to May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary-Treasurer*, George Jacobson, M.D., Box 146, 1200 N. State St., Los Angeles 33.

SAN DIEGO RADILOGICAL SOCIETY. *Secretary*, C. W. Bruner, M.D., 2456 Fourth Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADILOGICAL SOCIETY. *Secretary*, Tom M. Fullenlove, M.D., 110 El Verano Way, San Francisco 27. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADILOGICAL SOCIETY. *Secretary*, Herbert R. Berman, M.D., 309 St. Claire Bldg., San Jose. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Wm. W. Saunders, M.D., VA Hospital, San Francisco 21. Meets third Thursday at 7:45, Lane Hall, Stanford University Hospital.

Colorado

COLORADO RADILOGICAL SOCIETY. *Secretary*, Stuart A. Patterson M.D., Larimer County Hospital, Fort Collins. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, William A. Goodrich, M.D., 85 Jefferson St., Hartford 14. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, John A. Long, M.D., 1801 K St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADILOGICAL SOCIETY. *Secretary-Treasurer*, James T. Shelden, M.D., Box 1021, Lakeland. Meets in April and in October.

GREATER MIAMI RADILOGICAL SOCIETY. *Secretary-Treasurer*, Richard D. Shapiro, M.D., 541 Lincoln Road, Miami Beach. Meets monthly, third Wednesday, 8:00 P.M.

NORTH FLORIDA RADILOGICAL SOCIETY. *Secretary-Treasurer*, Ivan Isaacs, M.D., 1645 San Marco Blvd., Jacksonville 7. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADILOGICAL SOCIETY. *Secretary-Treasurer*, Albert A. Rayle, Jr., M.D., 490 Peachtree St. Meets second Friday, September to May.

GEORGIA RADILOGICAL SOCIETY. *Secretary-Treasurer*, Herbert M. Olnick, M.D., 417 Persons Bldg., Macon, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADILOGICAL SOCIETY. *Secretary* Wm. F. Hamilton, Jr., M.D., University Hospital Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, H. C. Chang, M.D., 1282 Emma St., Honolulu 13. Meets third Monday of each month.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, R. Burns Lewis, M.D., 670 N. Michigan Ave., Chicago 11. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, John A. Robb, M.D., 238 Hume-Mansur Bldg., Indianapolis 4. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer*, Stephen N. Tager, M.D., 219 Walnut St., Evansville 9, Ind. Meets last Wednesday, October, January, March, and May, 8:00 P.M., at the Elks' Club, Evansville, Ind.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, A. M. Cherner, M.D., Hays, Kansas. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, David Shapiro, M.D., Veterans Administration Hospital, Louisville 6. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer*, J. T. Brierre, M.D., 700 Audubon Bldg., New Orleans.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter A. Russell, M.D., Augusta General Hospital, Augusta. Meets in June, October, December, and April.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, Paul W. Roman, M.D., 1810 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

MARYLAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Paul W. Roman, M.D., 1810 Eutaw Place, Baltimore 17.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, E. F. Lang, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, John R. Hodgson, M.D., The Mayo Clinic, Rochester. Meets in Spring and Fall and at annual meeting of State Medical Association.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Packer, M.D., 621 High St., Jackson. Meets monthly, on third Tuesday, at 6:30 P.M., at the Hotel Edwards, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. E. H. Stratemeier, Jr., M.D., 1010 Rialto Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Wm. B. Seaman, M.D., 510 South Kingshighway, St. Louis 10. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary*, Grant P. Raitt, M.D., 413 Medical Arts Bldg., Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James F. Kelly, Jr., M.D., 816 Medical Arts Bldg., Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, B. Bruce Alicandri, M.D., 20 Maple St., Springfield, Mass. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Stanley M. Wyman, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, October through May, at the Hotel Commander, Cambridge, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary, Albert C. Johnston, M.D., 127 Washington St., Keene.*

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary, Carye-Belle Henle, M.D., 195 N. 7th St., Newark. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.*

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Clayton G. Weig, M.D., 135 Linwood Ave., Buffalo. Meets second Monday, October to May.*

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, and October.*

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary, Solomon Maranov, M.D., 1450 51st St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.*

NASSAU RADIOLOGICAL SOCIETY. *Secretary, Alan E. Baum, M.D., Hicksville, N. Y. Meets second Tuesday, February, April, June, October, and December.*

NEW YORK ROENTGEN SOCIETY. *Secretary, Sidney Rubenfeld, M.D., 477 First Ave., New York 16.*

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Donald H. Baxter, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.*

RADIOLOGICAL SOCIETY OF NEW YORK STATE. *Secretary-Treasurer, Mario C. Gian, M.D., 610 Niagara St., Buffalo. Meets annually with the State Medical Society.*

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer, Charles E. Sherwood, M.D., 260 Crittenden Blvd., Rochester. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.*

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Maynard G. Priestman, M.D., New Rochelle Hospital, New Rochelle, N. Y. Meets third Tuesday of January and October and at other times as announced.*

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary, Waldemar C. A. Sternbergh, M.D., 1400 Scott Ave., Charlotte 2. Meets in April and October.*

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary, Marianne Wallis, M.D., Minot. Meets in the Spring with State Medical Association; in Fall or Winter on call.*

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer, M. M. Thompson, Jr., M.D., 316 Michigan St., Toledo.*

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Arthur R. Cohen, M.D., 41 S. Grant Ave., Columbus. Meets second Thursday, October, November, February, April, and June, 6:30 P.M., Fort Hayes, Hotel Columbus.*

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer, H. F. Inderlied, M.D., 11311 Shaker Blvd., Cleveland 4. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.*

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Wm. R. Dickens, M.D., Cincinnati General Hospital, Cincinnati 29. Meets first Monday of each month, September to June, at Cincinnati General Hospital.*

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary, W. S. Koller, M.D., 80 Wyoming St., Dayton. Meets monthly, second Friday.*

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.*

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer, Fred C. Shipps, M.D., 214 Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club, Portland.*

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer, J. Richard Raines, M.D., 214 Medical-Dental Bldg., Portland 5, Ore. Meets annually in May.*

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.*

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary, Herbert M. Stauffer, M.D., Temple University Hospital, Philadelphia 40. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.*

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer, Donald H. Rice, M.D., 4800 Friendship Ave., Pittsburgh 24. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at the Hotel Roosevelt.*

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer, John H. Freed, M.D., 4200 East Ninth Ave., Denver 7, Colo.*

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer, William A. Klauber, M.D., Self Memorial Hospital, Greenwood. Meets with State Medical Association in May.*

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, Benjamin E. Greenberg, M.D., 294 Annella St., Memphis 11. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George K. Henshall, M.D., 311 Medical Arts Bldg., Chattanooga 3. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH RADIOLOGICAL CLUB. *Secretary*, Otto H. Grunow, M.D., 650 Fifth Ave., Fort Worth 4, Texas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, W. C. Owslay, M.D., 6409 Fannin, Houston 25. Meets fourth Monday at Texas Children's Hospital.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Building, San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Eva L. Gilbertson, M.D., 1317 Marion St., Seattle 4. Meets fourth Monday, September through May, at 610 Pine St., Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, W. Paul Elkin, 515-519, Medical Arts Bldg., Charleston. Meets concurrently with annual meeting of State Medical Society, and at other times as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. W. Moir, M.D., Sheboygan Memorial Hospital, Sheboygan.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Rafael A. Blanes, M.D., Box 9724 Santurce, Puerto Rico.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, D. L. McRae, M.D., *Assoc. Hon. Secretary-Treasurer*, Guillaume Gill, M.D., Central Office, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE. *General Secretary*, Ls Ivan Vallée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTS DE LA PROVINCE DE QUÉBEC. ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUÉBEC. *Secretary*, Jean-Louis Léger, M.D., 1560 Sherbrooke St. East, Montreal, P. Q. Meets four times a year.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. *Secretary*, Dr. Rafael Gómez Zaldívar. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA, A. C. *Headquarters*, Calle del Oro, Num. 15, Mexico 7, D. F. *Secretary General*, Dr. Eugenio Toussaint. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

ANNOUNCEMENT

Because of the demand for space in *RADIOLOGY* for publication of scientific papers, the listing of Radiological Societies, with secretaries and meeting dates, will in the future appear only four times yearly, in January, April, June, and October.

ABSTRACTS OF CURRENT LITERATURE

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The Head and Neck

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Central Veins and Deep Dural Sinuses of the Brain. An Anatomical and Angiographic Study. Curt Johanson. *Acta radiol. Supplement 107, 1954.*

The author of this monograph studied the position and appearance of the central veins of the brain and the deep dural sinuses under normal conditions as well as in the presence of intracranial expanding and atrophic processes. The material consisted of 75 autopsy cases and 200 normal carotid angiograms. A special contrast medium was used and the veins and sinuses were filled selectively and radiographed *in situ*. The roentgenological observations were then checked by dissection. The pathological material consisted of 103 cases of supratentorial expanding processes and 10 cases of symmetrical hydrocephalus.

Although variations in the position and appearance of the central veins and deep dural sinuses occur, these are relatively slight and can be recognized easily. The position of the central veins and the deep dural sinuses in relation to the different structures of the brain is practically constant. [For details of the anatomy of these structures the reader is referred to the excellent discussion in the original publication.]

In brief, the angiographic appearance of the central veins in abnormal intracranial conditions is as follows:

1. *Craniostenosis:* The central veins and deep dural sinuses vary in the same way in craniostenosis as they do in the absence of cranial deformity.

2. *Symmetrical Hydrocephalus:* The internal cerebral vein is displaced downward and backward but not laterally. The curves are straightened in proportion to the degree of dilatation of the lateral ventricles. Displacement of the basal vein may be a sign of herniation through the tentorial notch.

3. *Suprasellar and Parasellar Expanding Processes:* The upward, lateral, and posterior displacement of the central veins indicates the extent of the tumor. Displacement of the central veins implies that the expanding process is of considerable size.

4. *Frontal and Fronto-parietal Expanding Processes:* The internal cerebral vein is usually displaced across the mid-line in the same direction as the arteries but to a lesser degree. When the process is far anterior, the arterial displacement exceeds the venous displacement. This difference is not so great when the process lies more posteriorly.

Frontal lesions displace the anterior portion of the internal cerebral vein posteriorly. A subfrontal tumor deflects it upward. When the tumor is parasagittal or high in the convexity, the anterior portion of the vein is displaced downward. Frontoparietal processes also displace it downward but not backward. Lateral lesions cause lateral displacement. With extension of the process to the temporal lobe, the basal vein may be displaced.

5. *Parietal and Occipital Expanding Processes:* The internal cerebral vein is usually displaced more than the arteries. The displacement is beyond the mid-line. Parasagittal processes and those in the convexity may displace the vein downward. The posterior portion of the vein may be shifted upward when the process is located laterally. When an expanding process is situated suboccipitally, the postero-superior portion of the curve of the posterior cerebral

vein around the splenium of the corpus callosum may be straightened. It is only rarely possible to diagnose extension of a tumor to the lateral ventricle by means of the pattern of the central veins.

6. *Temporal Expanding Processes, Including Those in the Sylvian Fissure and the Insula:* The localization of the process is found to be indicated in particular by deflection and local deformation of the basal vein. The displacement is medially and/or upward or downward. The internal cerebral vein is displaced across the mid-line to a lesser degree than the basal vein but more than the arteries.

7. *Central Expanding Processes:* When there is no hydrocephalus the internal cerebral vein is almost constantly deflected in an upward curve. Any lateral displacement is dependent upon the site of the tumor. When hydrocephalus is present, the upward dislocation of the internal cerebral vein is counterbalanced by the ventricular dilatation, and the vein is displaced across the mid-line. The basal vein may be stretched and displaced downward.

The appendix to this publication describes a special measuring technic for determination of displacement of the central veins. It does not, however, disclose the presence of displacement to the same extent as do the changes in vascular pattern found on inspection.

One hundred and eleven case reports illustrate the author's observations, and a comprehensive bibliography is supplied.

One hundred and five roentgenograms; 24 photographs; 31 drawings; 5 tables.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Controlled Pneumoencephalography. A Consideration of Head Position and Gas-Fluid Replacement. Robert Shapiro and Franklin Robinson. *J. Neurosurg. 11: 122-127, March 1954.*

A very satisfactory method of controlled pneumoencephalography, described by Robertson and Lindgren (see, for example, Lindgren: *Acta radiol. 31: 161, 1949. Abst. in Radiology 54: 130, 1950*) has apparently been overlooked, as evidenced by the extensive literature on maneuvers and tomography. The authors have obtained successful filling of the third ventricle, aqueduct of Sylvius, and fourth ventricle in most cases, as well as delineation of the subarachnoid cisterns, by its use. The patients have experienced relatively little discomfort following the procedure.

The patient is placed in a sitting position with the head slightly flexed (approximately 20°), facing a vertical cassette holder. After several drops of fluid have escaped from the spinal needle, 5 to 8 c.c. of filtered air are slowly introduced. Postero-anterior and lateral films are then taken. If the posterior mid-line structures are not well visualized, the head may be manipulated by minor adjustments governed by the location of the air. Following successful demonstration of these structures, 5 to 8 c.c. of fluid are removed and 10 to 15 c.c. of air injected, the last 5 c.c. with the head in a neutral position, in order to fill the ventral basilar cisterns. Depending upon the desirability of filling the cerebral sulci, 5-10 c.c. more air may be introduced with the head markedly flexed. A total of eight films are then taken with the patient supine and

prone, and after specific filling of the temporal horns by appropriate positioning.

Manometric control of the cerebrospinal fluid pressure during this procedure has demonstrated an initial rise of 30 to 170 mm. of water (average, 90 mm.) following the initial injection of air. This was subsequently corrected by withdrawal of fluid. The method is not advocated in the presence of an obvious expanding intracranial mass lesion.

Five roentgenograms; 3 drawings.

E. E. TENNANT, M.D.
Denver, Colo.

A New Method for Correcting Distortion in Cranial Roentgenograms, with Special Reference to a New Human Stereotactic Instrument. Vernon H. Mark, Paul M. McPherson, and William H. Sweet. *Am. J. Roentgenol.* 71: 435-444, March 1954.

The authors described a new stereotactic instrument for better localization and roentgenographic study of lesions within the skull. With the aid of special graphs and charts, it affords a simple means of correcting measurements from appropriately taken roentgenograms to position precisely an intracranial electrode. As accessories to the stereotactic device, pairs of plastic plates, each containing two intersecting strips of lead, are used. For the procedure as originally performed it was essential that these plates, or "grids," be so placed, opposite each other, that on the roentgenogram they were exactly superimposed. A modified technique described in an Addendum to the paper obviates this necessity. This involves the placement of a chart of a head on a plotting board in exactly the same degree of rotation with respect to the central x-ray beam as that obtaining in the roentgenogram. Measurements from the film are transferred to this plotting board rather than to charts as in the original procedure.

No attempt will be made here to present the details of the stereotactic instrument and its use. Although the instructions appear rather complicated, the authors state that in actual operation the procedure requires only a few minutes.

This method of correction of the distortion which is normally seen on cranial roentgenograms is considered to be of great service to the neurosurgeon or the neuro-radiologist in accurately localizing lesions and foreign bodies.

Nine illustrations, including 1 roentgenogram; 2 charts.

O. M. RICHARDSON, M.D.
University of Louisville

Effect of Intracarotid Iodopyracet (Diodrast) Upon Cerebral Blood Flow. Byron M. Bloor, Frank R. Wrenn, Jr., and George Margolis. *Arch. Neurol. & Psychiat.* 71: 358-361, March 1954.

Experiments were performed on anesthetized young adult rabbits and *Macacus rhesus* monkeys by injection of iodopyracet (35 per cent and 70 per cent) into the carotid arteries. During each experimental period the animals were curarized and mechanically respiration. Electroencephalograms were recorded, and all the animals showing seizure electroactivity were excluded from the analyses, since it was felt that indications of increased blood flow might be due to the seizures rather than the effect of iodopyracet. In the monkeys the cerebrospinal fluid pressures were recorded from cisternal punctures. Estimates of changes

in blood flow were obtained by placing heated thermocouples as precisely as possible in the cerebral cortex of the animal, usually in the parietal region, through 2-mm. twist-drill holes in the skull.

The measured changes in blood flow were manifest in two phases following injection of iodopyracet: (1) the immediate response, during the first minute, and (2) the average response during the second through the fifth post-injection minutes. Of 20 observations of the cerebral blood flow in the injected hemisphere, 12 showed an initial increase and 8 a decrease, the latter always relatively small and of short duration. In all 20 instances the flow was increased after the first sixty seconds. In 12 studies of the blood flow in the hemisphere contralateral to the injection, 9 indicated an initial increase and in 10 there was an increase after the first minute. The principal reaction to intracarotid iodopyracet in the rabbit and the monkey, the authors conclude, appears to be vasodilatation.

The cerebrospinal fluid pressure responses were measured in comparison with those following control injections with Ringer's solution, and very little difference was encountered. No relationship was established between the cerebrospinal fluid pressure and either the amount (0.5 to 5.0 c.c.) or the rate (0.05 to 1.0 c.c. per second) of injection. Blood pressure changes were insignificant.

Three tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Sturge-Weber-Dimitri Syndrome. Cephalic Form of Neurocutaneous Hemangiomatosis. Ben W. Lichtenstein. *Arch. Neurol. & Psychiat.* 71: 291-301, March 1954.

Hemangiomatosis may affect single organs, the skin, the brain, the kidney, etc., or it may be limited to segments or regions of the body. In the Sturge-Weber-Dimitri syndrome the hemangiomatosis is generally limited to the mesenchyma lying in proximity to the ectoderm, and the vascular nevi are found in the skin, the conjunctiva, the choroid layer of the eye, and the leptomeninges.

The author presents one clinical and two clinical-pathologic reports of the syndrome. He lists the following pathologic alterations: an excessive number of thin-walled veins in the leptomeninges; an excessive number of blood vessels (chiefly veins and precapillaries) in the subcortical medullary substance; pericapillary sclerosis in the cerebral cortex underlying the excessively vascularized leptomeninges, with extreme disorganization of the cytoarchitecture and gliosis; sclerotic atrophy of the cerebral cortex with complete loss of nerve cells, extensive gliosis and pericapillary fibrosis, and sclerosis and degeneration of the subcortical medullary substance.

Double-contour linear densities seen in roentgenograms of the brain are outlines of cerebral convolutions (not of blood vessels). The substance in the cortex appearing as radioopaque densities has been found by histochemical determination to be calcium in the majority of instances, although it is sometimes iron. Apparently the pathogenesis of the cerebral cortical changes is a disturbed metabolism induced by venous stasis in the increased number of pial veins. Thus, there is nothing pathognomonic about the calcification of the cortex, for other pathologic conditions that interfere with the metabolism but not with the arterial blood supply produce a similar picture. In one of the

author's cases there was extensive sclerotic atrophy of the cerebral cortex but no calcification. He considers that a complete loss of nerve cells early in life may have resulted in a failure of blood flow to the affected areas, so that calcification or ferrugination could not take place. While the calcifications and the clinical picture may progress because of interference with nutrition and metabolism, there is no evidence that the hemangiomatosis is an active proliferative process.

Four roentgenograms; 8 photomicrographs; 1 photograph. **ARTHUR S. TUCKER, M.D.**
Cleveland Clinic

Bilateral Intracranial Aneurysms. Geraldine King, Harry W. Slade, and Francisco Campoy. *Arch. Neurol. & Psychiat.* 71: 326-336, March 1954.

In a series of 162 cerebral angiographic studies performed at the University of Pennsylvania Hospital on 121 patients suspected of having intracranial aneurysms, the diagnosis was confirmed in 57. Positive confirmation was obtained in a higher proportion of patients with subarachnoid hemorrhage (39 of 70) than of those without hemorrhage (18 of 51).

In 34 patients bilateral carotid angiograms were obtained. In this group, aneurysms were demonstrated in 18:12 unilateral and 6 bilateral. This incidence of bilaterality (33 per cent) is higher than that given in any previous report. Reports of the bilateral cases are included.

The authors agree with Poppen (*J. Neurosurg.* 8: 75, 1951. *Abst. in Radiology* 57: 763, 1951) that the internal carotid circulation of the opposite side should be investigated before a surgical procedure is instituted for a demonstrated aneurysm. They advocate vertebral angiography, not in all cases of suspected aneurysm, because the incidence is only 14 per cent, but whenever the symptoms point to the posterior circulation and when the lesion is not found with bilateral carotid arteriography.

In the present study, covering a period of thirteen years, 21 patients were found to have other vascular anomalies, such as angioma or arteriovenous malformations. In this group additional evidence, such as vascular lesions of the face, focal seizures, bruits, calcification or increased vascular markings on plain skull films, and increased cerebral blood flow, contributed to the diagnosis.

Six roentgenograms; 4 tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Basilar Artery Aneurysm. Report of a Case Diagnosed Roentgenologically. W. Eugene Stern. *Am. J. Roentgenol.* 71: 428-434, March 1954.

The author presents one case of basilar artery aneurysm and cites numerous published reports on basilar and vertebral aneurysms. The clinical picture of aneurysm of the basilar-vertebral complex includes: (1) symptoms of headache, nausea, vomiting, and the syndrome of increased intracranial pressure; (2) unilateral pyramidal tract involvement without sensory impairment; (3) paralysis of the caudal group of cranial nerves; (4) disturbances of equilibrium. Plain roentgenograms may show signs of general increase in intracranial pressure, evidence of local bone erosion, and calcification within the aneurysmal lesion.

Special ventriculograms and angiographic studies reveal the nature of the lesion, posterior fossa aneurysms being most important.

Eight roentgenograms; 1 drawing.

JOHN F. BERRY, M.D.
University of Louisville

Tumors of the Foramen Magnum of Spinal Origin. Edmund A. Smolik and Ernest Sachs. *J. Neurosurg.* 11: 161-172, March 1954.

Tumors which arise in the upper cervical cord and extend upward into the foramen magnum, *i.e.*, spinocranial tumors, may be present more frequently than the reported incidence suggests. The rather bizarre findings in cases diagnosed as demyelinating disease or an infectious process may at times be due to unrecognized tumor. Such tumors will be diagnosed only by careful correlation of symptoms, signs, spinal fluid dynamics, chemistry, and the myelographic observations.

The authors report 6 cases of spinocranial tumors, from a series of 234 spinal tumors, pointing out the insidious onset, variability of symptoms, and the frequency with which an early diagnosis was missed. Only when compression of the cord begins do signs become definite and identifiable. Sooner or later, pain, stiffness of the neck, or suboccipital headache develop. Sensory and/or motor changes are usually homolateral. Bladder or sexual disturbances may appear later. The total protein content of the cerebrospinal fluid was elevated in all the authors' cases, and myelographic changes were present.

One case in which a Cushing's syndrome disappeared following removal of the tumor is of particular interest.

Three roentgenograms; 2 photographs; 2 tables. **E. E. TENNANT, M.D.**
Denver, Colo.

Cranial Aerocele. Franklin Jelsma and Dudley F. Moore. *Am. J. Surg.* 87: 437-449, March 1954.

Air may collect externally under the pericranium or internally in any of the various spaces within the skull, as a result either of injury or infection (or both) producing an abnormal communication to the external air or to one of the air spaces around the nose or ear.

Acute cases are not significant in themselves but the presence of the air is a warning of potential danger of infection. If the communication remains open, the collection of air will persist and enlarge, especially when there is a valve mechanism at the fistula site. The usual signs of increased intracranial pressure may be found—headache, nausea and vomiting, slow pulse, disturbances of consciousness etc. Rhinorrhea is a clue to the diagnosis when it can be determined to be present and should be an indication for roentgenography. Roentgenograms will give information about the location and extent of fracture, and possible chronic infection of the sinuses and mastoids, and will reveal the presence of air. The latter occurs usually after the initial effects of the injury have subsided.

Treatment is surgical, with closing of the fistulous tract by bone wax, Gelfoam, or similar material. Proper surgical care of compound injuries and thorough antibiotic therapy in sinus fractures should help in preventing aerocele.

Ten roentgenograms. **ZAC F. ENDRESS, M.D.**
Pontiac, Mich.

Osteoporosis Circumscripita of the Cranium (Second Disease of Schüller) and Monophasic (Osteolytic) Cranial Manifestations of Paget's Disease. Renzo Bossi and Giovanni Pisani. *Radiol. med. (Milan)* 40: 209-227, March 1954. (In Italian)

The authors report 3 cases of extensive osteolytic involvement of the cranium, of which 2 were followed several years. Even with repeated observations, the first case preserved its radiologic characteristics of pure osteoporosis with no superimposition of osteodystrophic elements and with no evidences of Paget's disease in other parts of the skeleton. On the other hand, the second case presented clear evidence of persistence of bony elements in the osteoporotic lacunae, with associated changes of "leontiasis" in the maxilla and lesions of Paget's disease in the pelvis. Biopsy confirmation was obtained in this instance. The third case was an example of cranial osteoporotic involvement still relatively limited, but with beginning osteodystrophic changes, without evidences of Paget's disease elsewhere in the skeleton (monophasic and monostotic Paget's disease).

On the basis of their own observations, and those in the literature, the authors believe that they are able to distinguish two groups of cases. The larger of these comprises those cases which are a manifestation of Paget's disease, of which the second and third cases described above are examples. The second group, in which only a few observations have been made, including the authors' first case, presents a definite radiologic appearance which clearly separates it from Paget's disease. It is believed that only the cases in this second group should be designated osteoporosis circumscripita of the cranium (or the second disease of Schüller). The other group characterized by osteodystrophic osteolytic changes should be called the monophasic stage of Paget's disease.

Fifteen roentgenograms; 4 photomicrographs.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

A Special Form of Generalized Hyperostosis with Leontiasis Ossea. Franz Sommer. *Radiol. clin.* 23: 65-75, March 1954. (In German)

The interpretation of leontiasis ossea varies from author to author. It is not a sharply outlined disease entity, but is to be regarded as an indication of any one of several underlying diseases. It is simply a descriptive name applied to the patient's appearance due to hyperplastic changes in the bones of the skull. A case is reported here with an underlying disease apparently not previously described.

The patient was a 19-year-old girl who showed a generalized thickening and expansion of the bones, most notable in the skull. The medullary cavity of the long bones was largely replaced by spongiosa. The compacta was normal. The fundamental abnormality was considered to be a hyperplasia of the endosteum, but only the phalanges showed sclerosis to any degree. Biopsy of the bones was not permitted. No anemia or disturbances in calcium metabolism were found. Examination of the mother showed slight changes in the phalanges, indicating a possible hereditary factor.

In the differential diagnosis, the author considers at length those diseases which may be found with leontiasis ossea, such as Paget's disease, osteitis fibrosa of von Recklinghausen, and polyostotic fibrous dysplasia.

These entities were easily excluded. Since the case showed many features in common with Albers-Schönberg and Camurati-Engelmann's diseases, the author feels that it is related to these entities. The three conditions are compared.

Six roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Metabolic Craniopathy. Report of Two Cases Associated with Osteopoikilosis. Howard B. Appelman and Robert C. Moehlig. *Am. J. Roentgenol.* 71: 420-427, March 1954.

Metabolic craniopathy is a clinical syndrome in which a metabolic dyscrasia, probably a dyspituitarism, causes a hyperostosis and various symptoms which could be attributable either to pituitary dysfunction or to pressure resulting from hyperostosis frontalis interna. The authors report two such cases (in a mother and daughter) associated with osteopoikilosis. The latter condition is characterized by disseminated condensation of the bones of the skeleton. Multiple areas of increased density from 2 mm. to 2 cm. are found in the spongiosa of the epiphyses. The etiology is unknown, but the disease is thought to be on a congenital basis.

The symptoms of metabolic craniopathy include headache, obesity, muscular weakness and fatigue, nervousness, confusion, anxiety and depression, memory defects, dimness of vision and occasional diplopia, epileptiform seizures, disturbances in equilibrium, and other manifestations of disturbed pituitary function. Osteopoikilosis is generally said to be symptomless but cases have been reported with symptoms not unlike those of metabolic craniopathy.

The authors believe that there is strong evidence of the hereditary nature of osteopoikilosis and of the sex-linked hereditary nature of metabolic craniopathy, the latter probably being inherited as a dominant trait.

The literature on both diseases is reviewed.

Six roentgenograms. JOHN WATTS, M.D.
University of Louisville

Craniostenosis with Familial Vitamin-D-Resistant Rickets. E. N. Coleman and J. B. Foote. *Brit. M. J.* 1: 561-562, March 6, 1954.

A case of craniostenosis associated with vitamin-D-resistant rickets is presented. This is the second such case to be reported, and it is suggested that the association of these conditions may have occurred previously and been mistaken for a purely rachitic phenomenon.

Rickets was first diagnosed when the patient was between two and three years of age. A photograph taken at twenty months shows him walking normally, but the skull deformity was already apparent. There was some improvement demonstrable roentgenographically in the calcification of the bones over a two-year period. The patient's mother showed typical changes of healed rickets but no scaphocephaly.

Three roentgenograms; 2 photographs.

Osteomyelitis of the Frontal Bone of Rhinogenic Origin. A Report of Three Cases. Charles I. Johnson. *Ann. Otol., Rhinol., & Laryng.* 63: 180-188, March 1954.

This is a report of 3 cases of osteomyelitis of the frontal bone without overlying soft-tissue edema.

The early roentgenograms in this condition are negative, but surgery should not be delayed until they become positive, since this entails a waste of one to two weeks. Operation should be radical. When an extradural abscess is encountered, a brain abscess should be considered, especially if the border is poorly defined.

Six roentgenograms; 3 photographs.

PAUL MASSIK, M.D.
Quincy, Mass.

The X-Ray Diagnosis of Orbital Tumors. P. Thomas Manchester, Jr. *South. M. J.* 47: 231-234, March 1954.

The author, in a paper presented before the Section on Ophthalmology and Otolaryngology of the Southern Medical Association, discusses the value of roentgenography in the diagnosis of orbital tumors. He describes briefly the use of some of the newer x-ray techniques—tomography, emphysema, angiography, and contrast orbitography—in the study of these neoplasms.

Carcinoma of the Maxillary Antrum. Walter L. Mattick and Milton A. Streuter. *Surgery* 35: 236-242, February 1954.

An analysis of the clinical features and treatment of 68 cases of cancer of the maxillary antrum is presented. The prevalence in men was about twice that in women; the greatest incidence was between the fifty-sixth and seventy-fifth years.

Regional node metastasis was noted in 25 per cent of the cases on initial examination. This, along with other evidences of extension of the tumor beyond the confines of the maxillary antrum, led the authors to classify 52 of the 68 cases as in the advanced stage. On histopathologic examination, 38 of the specimens showed differentiated types of squamous-cell carcinoma, 25 anaplastic carcinoma, 3 papillary, 1 a glandular epithelial formation, and 1 an epithelial neoplasm somewhat suggestive of an adamantinoma. Roentgenograms revealed clouding of the antrum in 60 of the cases and incidentally, in all 7 patients with five-year survival. Sclerosis and/or irregularity of the outline of the antrum was noted in 25 cases. Bone destruction was demonstrated in 23 instances, but in only 2 patients surviving as long as two years.

Treatment in this series was varied, consisting of roentgen irradiation, intracavitary radium, radium moulds, or a combination of these, and usually conservative surgery. The dosage of radiation from the different sources was quite varied. The absolute, overall five-year cure rate was 15 per cent, with a relative cure rate of 35 per cent in early cases.

Three photographs; 2 tables.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Retropharyngeal Soft Tissue Swelling Due to Whiplash Injury. J. W. Birsner and W. H. Leask. *Arch. Surg.* 68: 369-373, March 1954.

Swelling of the retropharyngeal soft tissues has been a recognized accompaniment of fracture and/or dislocation of the cervical spine. The authors point out that the swelling may occur in instances of whiplash injury, usually incurred in automobile accidents, where deceleration is abrupt, without evidence of fracture and/or dislocation. In reviewing the roentgenograms of 121 cervical spines they found 9 instances

of swelling of the retropharyngeal soft tissues due to whiplash injury and 10 cases resulting from other trauma. The criteria used for the normal range of thickness of the retropharyngeal soft tissues are those given by Hay and printed by Barton Young in Volume II of *Golden's Diagnostic Roentgenology*. [Some confusion may result from a misprint in this table as reproduced by the authors. Two columns of upper normal limits are headed "Postpharyngeal Soft Tissue," whereas the second column should be headed "Postlaryngeal Soft Tissue," as given in *Diagnostic Roentgenology*, Vol. II, p. 897.—A.S.T.]

After any severe injury to the neck, routine views of the cervical spine should be obtained as soon as possible. If there is any indication of swelling of the retropharyngeal soft tissues, a repeat lateral view should be taken in twenty-four hours. In the absence of fracture, multiple views (laminagrams) may be indicated. If the retropharyngeal swelling subsides within seventy-two hours it is considered to be due to edema; if it resolves more slowly the authors believe that hemorrhage plays a part.

It is suggested that patients who have sustained injuries causing retropharyngeal swelling be observed for a period of years, with the possibility in mind that their injuries may lead to the later development of degenerative disk disease or formation of osteophytes.

Four roentgenograms; 2 tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Hypothyroidism in Negro Children. Roland B. Scott and Melvin E. Jenkins. *J. Pediat.* 44: 307-312, March 1954.

Few cases of cretinism among Negro infants and children have been recorded. This article contains 3 case reports of hypothyroidism occurring in Negroes. The hypothyroidism in all 3 cases was probably prenatal in origin.

Two children aged eleven and ten years presented the typical roentgen findings of delayed skeletal maturation and epiphyseal dysgenesis of the proximal femoral epiphyses on both sides. The bone age was two and a half and five and a half years, respectively. The third child was twenty-six months of age when examined. Roentgenograms revealed no ossification centers at the wrist and only four at the ankle.

Six roentgenograms; 3 photographs.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

THE CHEST

Duration of Action of Pontocaine Solutions With and Without the Addition of Adrenalin upon the Human Tracheo-Bronchial Mucous Membrane: Experimental Studies. L. Barth. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 396-400, March 1954. (In German)

The question as to whether adrenalin should be added to the Pontocaine solution used for local anesthesia of the tracheobronchial tree preparatory to bronchoscopy is debatable. Various contradictory articles have appeared in the literature. Keil and Vieten reported on the basis of animal experiments that addition of adrenalin to the Pontocaine markedly increased the toxicity and therefore was contraindicated (*Fortschr. a. d. Geb. d. Röntgenstrahlen* 77: 409, 1952. *Abst. in Radiology* 61: 282, 1953). Barth felt, however,

that these experiments could not be used without reservation as a basis for the procedure to be employed in the human being. He therefore subjected 8 volunteer patients to local anesthetization of the trachea and of the bronchi with Pontocaine solution with and without added adrenalin.

The technic of the examination was as follows: 4 c.c. of a 2 per cent solution of Pontocaine was prepared for each examination, and carefully measured quantities of a solution of adrenalin, 1:1,000, were added. The anesthetic was applied to the soft palate and the epiglottis with an applicator; the larynx, the trachea, and the large bronchi were anesthetized by means of the laryngeal syringe. By extending the procedure over a period of from fifteen to twenty minutes, it was possible to obtain satisfactory anesthesia with an average of only 2.8 c.c. of the prepared solution. A semi-rigid polyvinyl plastic intubation tube was then introduced intralaryngeally, and by means of a thin catheter inserted through this tube, the area of the carina and of the large bronchi was tested for sensitivity at regular intervals of five minutes. If the test produced coughing, it was considered positive.

On the basis of his experiments, the author has reached a number of conclusions. Without the addition of adrenalin, the anesthesia lasts, on an average, fourteen minutes; with the addition of adrenalin, it lasts twenty-four minutes. A similar increase in duration can be obtained by an adrenalin concentration of but 1:40,000. Larger amounts will not materially prolong the anesthesia. The author does not believe that the adrenalin increases the toxicity of the Pontocaine, nor does he believe that it exerts any potentiating effect on the Pontocaine. He attributes the effect solely to vasoconstriction.

The guiding principle in anesthetization should be a slow, step-by-step induction, over a period of at least fifteen minutes. For rapid anesthetization, considerably larger amounts of the anesthetic must be used. This probably accounts for the toxic reactions reported by some authors following the use of adrenalin.

One table. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Mass X-Ray Surveys. H. W. Wunderly. M. J. Australia 1: 349-353, March 6, 1954. **Technical Aspects of Miniature Radiography.** C. E. Eddy. Ibid., pp. 353-355.

These two papers were presented in a Symposium on Mass X-ray Surveys held by the Victorian Branch of the College of Radiologists of Australasia. The first is concerned with the administrative aspects. In countries like Australia, where the incidence of tuberculosis is relatively low, it would be satisfactory to perform a tuberculin skin test first and limit radiography to the positive reactors. The practice has been, nevertheless, to obtain roentgenograms of all members of the population over the age of fourteen.

It has been the author's experience that mistakes connected with miniature radiography are more often attributable to misinterpretation than to poor films. Since fatigue is an important cause of errors in interpretation, it is recommended that not more than 250 radiographs per session of not more than one hour should be viewed by any one examiner and that each examiner be limited to two such sessions per day. Two interpreters should survey each set of films.

Persons with "abnormal" miniature radiographs are

asked to return for a large film, at which time an interview with a trained nurse or medical social worker is recommended to obtain pertinent information as to the history. If the abnormality is confirmed on the large film, the subject is then seen by the medical director of the survey unit, who explains the necessity for further investigation under private auspices. The unit is later informed of the ultimate diagnosis.

One to three persons per 1,000 radiographically examined are found to have tuberculosis in a form requiring treatment. Because of a higher incidence of tuberculosis in these groups, surveys are especially indicated for patients referred by physicians and for hospital in-patients and out-patients. Other groups which should be investigated include all contacts, women attending prenatal clinics, applicants for public employment, hospital employees, and miners.

The second paper deals with the equipment necessary for mass radiography and with matters of technic. The author is particularly concerned with the maintenance of a high technical standard in the films being produced and offers some suggestions for control of the work of the teams of radiographers [not radiologists] who are responsible for these surveys in Australia.

Four charts. RICHARD E. BUENGER, M.D.
Chicago, Ill.

Serial X-Ray Examinations in the Iron and Steel Industry from 1949 to 1953 (The Results of Compared Yearly Examinations in Pulmonary Tuberculosis and Bronchogenic Carcinoma). K. Liebschner, H. Vieten, and K. H. Willmann. Fortschr. a. d. Geb. d. Röntgenstrahlen 80: 302-314, March 1954. (In German)

The authors report the results of a comparative study of yearly chest films over a period of four years in 150,000 iron and steel workers. About 600,000 films were taken with a microfilm apparatus using 31 X 31-mm. films. The observations made were classified as pulmonary, diaphragmatic, cardiovascular, and skeletal findings. Of the greatest interest were the pulmonary findings, particularly tuberculosis and bronchogenic carcinoma. The routine comparison of the film of each person with those taken in the previous years necessitated a great deal of work, but is considered to have paid handsome dividends in earlier recognition of lesions and in their better evaluation.

The number of new active cases of tuberculosis requiring treatment declined during the four years (1949-1953) from 0.5 per cent to about 0.25 per cent, that is, by 50 per cent. Regarding carcinoma, a study of the earlier (1950) films was disappointing. Lesions that were carcinomatous were considered to be tuberculous in the early stages, and by the time the correct diagnosis was made, the disease had progressed so far that it was frequently inoperable. In the following years, however, a comparison of the films with those made previously showed certain characteristics which strongly pointed toward a diagnosis of cancer, with the result that the percentage of recognized bronchogenic carcinomas increased from 0.013 per cent to 0.049 per cent, that is, almost four times. This has given the yearly microfilm examination a new aspect and it is to be expected that its significance in the future, if comparative studies are made, may be greater for the detection of carcinoma than of tuberculosis.

Ten roentgenograms; 2 graphs; 3 tables.
WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Bronchogenic Carcinoma: Analysis of 201 Proved Cases. Clarence H. Steele. *Ann. Otol., Rhinol. & Laryng.* 63: 5-21, March 1954.

This is a review of 201 cases of bronchogenic carcinoma seen in a large clinic. It presents a brief history of the disease and then analyzes the cases. The following significant features are brought out:

- (1) The incidence in males is increasing more rapidly than that of any other malignant neoplasm.
- (2) Eighty-seven per cent of the series were men.
- (3) Of the 43 patients with adenocarcinoma, 35 per cent were women.
- (4) Only 5 per cent of the cancers were alveolar-cell tumors.
- (5) If the diagnosis of bronchogenic cancer cannot be ruled out clinically, exploratory thoracotomy is indicated.

The remainder of the article is well written, in general text-book style. It should be consulted for a brief routine review.

Five tables.

PAUL MASSIK, M.D.
Quincy, Mass.

Primary Leiomyosarcoma of the Lung. William L. Watson and Alexander J. Anlyan. *Cancer* 7: 250-258, March 1954.

The authors present 6 cases of leiomyosarcoma of the lung, 3 of which were successfully treated by surgical excision. The cases were equally divided between the sexes. The youngest patient was four years of age and the oldest sixty-seven. The duration of symptoms varied from one month to several years, and the most common presenting symptoms were cough, dyspnea, and chest pain. Hemoptysis occurred in 1 case.

There were no specific physical findings. Roentgen studies disclosed some abnormality associated with a mass in all cases. Bronchoscopy revealed the lesion in only 1 instance, Papanicolaou cytological study was "suspicious" in only 1 case.

Two tumors arose from the middle lobe, 1 in the left upper lobe, 2 in the left lower lobe, and 3 in the right main-stem bronchus. Four of the tumors were encapsulated; only 1 had spread widely. No enlarged lymph nodes were present in any of the cases.

In the 3 instances where definite operations were performed, the patients were alive and free of disease three years, five years, and six years respectively. One patient had a non-resectable tumor and died ten months after exploration; roentgen therapy afforded some symptomatic improvement, with slight regression of the mass. One patient died at operation, and the other refused surgery and died two years after the diagnosis had been established.

These tumors spread late and, in an early stage, can be removed by surgical excision. With complete removal, the chances for cure are high. When the tumors are beyond surgical reach, roentgen therapy may have some palliative value.

Twelve roentgenograms; 4 photographs; 6 photomicrographs.

THEODORE E. KEATS, M.D.

University of California, S. F.

Eosinophilic Granuloma of Lung: Report of Three Cases. Ivan A. May, Jack M. Garfinkle, and David J. Dugan. *Ann. Int. Med.* 40: 549-562, March 1954.

Eosinophilic granuloma has been considered by most writers to be related to Hand-Schüller-Christian

disease. The present authors report 3 cases of pulmonary eosinophilic granuloma which tend to support this concept. In 2 cases there were associated eosinophilic granulomas of bone. In the third case an osteolytic lesion was demonstrated roentgenographically in the left femur, but only the lesion in the lung was biopsied. The patient also had diabetes insipidus and questionable exophthalmos. Although roentgenograms of the skull did not reveal any bony abnormality, the case is regarded as an instance of Hand-Schüller-Christian disease.

The pulmonary lesions in all 3 cases were similar pathologically. The cellular alterations resembled the pattern diagnosed as eosinophilic granuloma of bone or other structures, as well as Hand-Schüller-Christian disease. In the smallest pulmonary nodules, the infiltration was of an interstitial nature, and eosinophils or histiocytes were no more numerous than accompanying lymphocytes and neutrophils. The alveolar spaces remained patent. With progression of the disease, there was marked thickening of the interstitial tissue, coupled with encroachment on the air spaces. Gradually the alveoli became filled with the inflammatory cells or they collapsed completely, and an obliterative nodule was formed. Coalescence of such granulomatous foci produced a larger nodular lesion that replaced the lung parenchyma. An interesting feature of the coalescent nodule was the occasional outlining of dense masses of histiocytes by a ring or halo of eosinophils.

Five roentgenograms; 8 photomicrographs.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Right-Sided Subphrenic Abscess with Perforation into the Bronchial Tree (Thoracic Symptoms and Diaphragmatic Complications of an Unusual Syndrome). Mario Rossetti. *Radiol. clin.* 23: 109-115, March 1954. (In German)

Subphrenic abscess is a rarity today because of advances in abdominal surgery and the use of modern antibiotics.

The author's patient, a 35-year-old man, gave a history of fever, pain, and a sensation of fullness in the right upper abdomen, with a cough productive of bloody purulent sputum. Two years earlier he had had amebic dysentery in Indochina, but this was supposedly completely cured. When seen in the hospital, the patient showed signs of pneumonia in the right base, spasm in the right upper abdomen, with radiation of pain into the right shoulder, fever, and blood findings indicative of an infectious process. About 50 c.c. of sputum was expectorated daily. On clinical grounds a subphrenic abscess with perforation into the bronchial tree was suspected.

Roentgen examination showed slight elevation of the right hemidiaphragm with suspension of respiratory excursions; no pleural effusion; coarsely striated right paracardial pulmonary markings; a circumscribed irregular elevation in the medio-anterior quadrant of the diaphragm projecting into the lung field. The inferior edge of the liver was displaced caudally. No subphrenic gas was seen. Posterior laminagrams disclosed a shadow in the posterior basal portion of the right lung, which might represent either a pneumonic infiltrate or atelectasis. Anterior laminagrams showed stringy thickening of the pulmonary markings radiating from the hilus toward the elevation

in the diaphragm described above. It may be that these markings represented pus-filled middle lobe bronchi with peribronchial reaction, since it was not possible to fill the middle lobe bronchi completely.

The roentgen findings were interpreted as confirming the clinical impression of subphrenic abscess with drainage into the bronchial tree. A subphrenic abscess cavity was opened and drained transpleurally. The cough stopped, the general condition improved, and the temperature and blood picture became normal. The abscess was attributed to a perforated appendix.

The author reviews the evidences for transdiaphragmatic spread of subphrenic abscess. The abscess itself is indicated by elevation and fixation of the diaphragm, depression of the liver caudally, gas with fluid level. There follow a diaphragmatic pleurisy and pleural effusion, which if purulent has an unfavorable prognosis. Basal atelectatic and pneumonic infiltrates are also seen and rarely, as in the present case, perforation into the bronchial tree. This process is not as simple as perforation into the pleural space, but the pleural layers and the lung parenchyma must be perforated before the bronchi are reached. Drainage through the perforation into the bronchial tree is usually inadequate and must be supplemented surgically.

Four roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Bronchial Resection and Anastomosis. Report of a Case. J. A. Gravel. *J. Thoracic Surg.* 27: 244-250, March 1954.

The author reports a case of pulmonary tuberculosis in which bronchial resection and anastomosis were performed. Cavities were present in the left upper lobe and in the apical segment of the left lower lobe, and there was a marked stenosis of the left main bronchus. At operation it was found necessary to remove the whole upper lobe and the apical segment of the left lower lobe. After resection of the involved segments the left main bronchus was transected proximal to the stenotic area, the lower lobe bronchus was transected just below the orifice of the apical segment, and the two ends were united.

After surgery, the left lower lobe expanded well. Four months later, however, the patient coughed up blood. A tomogram at this time showed a dense mass to the left of the trachea and above the bronchus on the left. An exploratory thoracotomy was considered, but a massive hemoptysis occurred, followed by death.

At autopsy the bronchial anastomosis was found to be healed and covered with normal mucosa. The mass seen on the tomogram proved to be a dense fibrous mass adherent to the mediastinum and to the superior and posterior parts of the aorta. In the center of the mass was thick sterile pus. In the region of the apical segment was an organizing hematoma which seemed to have infiltrated its way into the lung substance. The postmortem diagnosis was aortic aneurysm ruptured into the surface of the remaining segment of the lower lobe. Since the aorta had appeared normal at operation, the author believes that the inflammatory reaction and raw surfaces left by the apical resection may have caused the damage.

Seven roentgenograms; 3 drawings.

R. G. FORTIER, M.D.
St. Paul, Minn.

Circulatory Status of Resected Tuberculous Pulmonary Lobes. Raymond J. Barrett, Mikio Masaki, and J. C. Day. *J. Thoracic Surg.* 27: 277-284, March 1954.

Pulmonary arteries are end arteries, and obliterative endarteritis is a characteristic feature of pulmonary tuberculosis. The changes in the circulation to an involved lobe in tuberculosis are permanent.

In view of the frequency with which segmental resections are being performed for tuberculosis, the authors undertook the study of the blood supply in lobes removed for that disease. Of 35 resected lobes 14 met the requirements for this study. Four cases form the basis of the present report. In 3 of the cases the segments involved showed impairment of circulation despite x-ray evidence of clearing of the parenchymal infiltration. The fourth case showed unusually good circulation in view of the extent and duration of the infiltration. It is concluded that, if an entire lobe has been involved by disease, arterial impairment of that entire lobe can be expected in spite of parenchymal clearing prior to resection.

Operations to remove only residual caseous foci may eliminate dangerous areas of disease, but they may leave poorly vascularized lung, which is capable of only a minimal or negligible gaseous exchange. The retention of non-functioning segments does, however, prevent over-distention of the remaining uninvolvled lobes and may serve a space-filling function.

The authors conclude that the ultimate solution of this problem must await a practical procedure for function testing of smaller pulmonary units.

Twenty roentgenograms. R. G. FORTIER, M.D.
St. Paul, Minn.

Celomic Cysts of the Mediastinum. Robert D'Alo'. *Radioi. med. (Milan)* 40: 250-262, March 1954. (In Italian)

After a review of the literature of celomic cysts of the mediastinum, the author reports a case in a 29-year-old man, with extensive studies both in expiration and inspiration, supine and upright, supplemented by laminagraphy and bronchography. The findings were confirmed surgically. Histologic examination showed that the wall of the cyst consisted of a loose connective tissue with scattered small-cell inflammatory infiltrations. Its lining was covered in part by a single layer of cuboid cells which at times tended to stratify.

While the exact method of origin of these cysts is not known, it is commonly accepted that they are embryologic, probably related to the failure of complete confluence of the lacunae in the primitive mesenchyme during the formation of the pericardial cavity. If the communication with the pericardial cavity persists, we have a diverticulum; if not, a celomic cyst. Modifications of this fundamental theory have been proposed to explain the predilection of these cysts for the cardiophrenic angles, and also to explain the occasional cyst that is not in direct contact with the pericardium. Whatever their origin, it is certain that the cysts remain for a long time as potential cavities and become manifest only later in life. What causes the progressive increase of fluid in the cavity is unknown.

Usually celomic mediastinal cysts are asymptomatic and are found incidentally. At times, however, they may produce cough, dyspnea, a sense of precordial oppression, neuralgic pains which radiate from the arm

to the shoulder, tachycardia, digestive disturbances, and bronchial asthma. These disturbances are usually slight and probably are attributable to compression.

The author makes an important point of the changes in shape of the cysts in relation to the phase of respiration and variation in position. Such changes, however, are characteristic of mediastinal cysts in general, and not of celomic cysts in particular. Depending on the tension of fluid and the rigidity of the walls of the cyst, they may be absent altogether.

The discussion of differential diagnosis is limited to other cystic formations of the mediastinum. 1. *Dermoid cysts* occur usually in the anterior mediastinum, either low or high; they are not of homogeneous opacity, presenting foci of bony or calcareous density. 2. *Bronchogenic cysts* are found in the posterosuperior part of the mediastinum at the level of the bifurcation of the trachea. Radiologically, they are characterized by sharp and regular boundaries, homogeneity, and small volume. 3. *Lymphatic cysts* are related to the development of the lymphatics; they contain a liquid similar to lymph and are lined with stratified endothelium. They are rare and are usually recognized by the pathologist rather than the radiologist. 4. *Esophageal gastro-enteric cysts* contain mucosa of the alimentary canal. They are almost always found in the posterior mediastinum, in the form of rounded masses with regular and sharp contours, dense and homogeneous opacity, often involving the lower half of the esophagus, with the production of dysphagia. 5. *Thymic cysts*, except for their position in the retrosternal region, offer no really good distinguishing features. 6. For *parasitic cysts* (usually echinococcal) Casoni's reaction and eosinophilia must be depended upon.

While many different formations can produce an identical radiologic picture, the following findings in a patient with minimal signs and symptoms are most suggestive, if not pathognomonic, of this condition: an oval or tear-like mass in the cardiophrenic angle not separable from the cardiovascular shadow; change in shape of the mass during respiration and variation in position; either no pulsations in the mass or only slight transmitted ones. All these findings together are rare. None is pathognomonic. It is particularly difficult if not impossible to make the diagnosis when the cysts are distant from the diaphragm and separate from the cardiovascular shadow.

Eight illustrations, including 6 roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

THE CARDIOVASCULAR SYSTEM

Indications for Angiocardiography. George Jacobson and John M. Clark. California Med. 80: 168-172, March 1954.

Angiocardiography is indicated in selected cases of heart disease in which a definite diagnosis cannot be made by ordinary methods or in which there is reasonable expectation that information thus obtained may influence the treatment. Whenever possible, the procedure should be done in conjunction with cardiac catheterization. The main indication is cyanotic congenital heart disease, particularly those cases with a right-to-left shunt.

The *tetralogy of Fallot* and *Eisenmenger's complex* can in most instances be differentiated with a reasonable degree of certainty without either catheterization or

angiography. A sufficient number of erroneous diagnoses have been made, however, to justify the performance of both procedures to establish as exact an anatomic and physiologic diagnosis as possible. The degree of pulmonary stenosis and right ventricular and/or pulmonary hypertension, the amount of left-to-right shunt flow through the interventricular septal defect, and the presence of other unsuspected left-to-right shunts can be determined only by catheterization. Angiocardiography is not only a more accurate means for demonstrating the overriding aorta, but is more efficient for estimating the volume of blood flow from the right ventricle into the aorta. It also serves to visualize unsuspected right-to-left shunts and is of aid in determining the availability of vessels for surgical anastomosis.

In *pulmonary stenosis*, angiography will rarely show the actual stenotic area. It will, however, demonstrate the poststenotic dilatation of the artery, which is the most reliable sign of valvular stenosis as opposed to fundibular stenosis.

True *truncus arteriosus* can be diagnosed only if it can be shown that there is no functioning pulmonary artery, and angiography is the only means of determining this.

In *tricuspid atresia* or *stenosis*, angiography may demonstrate the size of the interatrial septal defect and possibly the size of the pulmonary artery. In *transposition of the great vessels*, the procedure is chiefly of confirmatory value. Other valid indications for the examination include *pulmonary arteriovenous fistula* (to rule out multiple lesions), *anomalies of the aorta* (duplication, hypoplasia, coarctation), *fibrosis pericarditis*, and the differentiation of *mediastinal tumors* and *aortic aneurysms*.

Seven roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Aortography: A Discussion of Technique and Complications. A. Justin Williams, Tom M. Fullenlove, and John R. Bryan. California Med. 80: 165-167, March 1954.

In a series of 113 translumbar aortographies the authors had 1 fatal cardiovascular reaction and 15 non-fatal complications. Fifty cubic centimeters of 70 per cent Diodrast was used in the majority of the cases, including all those in which complications were observed. More recently 70 per cent Urokon has been used and 25 to 30 c.c. has been found to produce excellent aortograms, with a minimum of reactions. The authors briefly present 3 cases of thrombosis or aneurysm formation, with aortograms for each.

Four roentgenograms; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Transosseous Serial Phlebography. Marcelo H Moreau and Guillermo Gallo Morando. Rev. argent. de radiol. 17: 21-32, 1954. (In Spanish)

The authors introduce their work with a brief review of the anatomy of the venous system of the lower limb, a classification of the types of varices, and a discussion of the technic for phlebography used by various investigators. All technics fall into one of two classes: descending and ascending. The descending is especially useful for the deep venous system, in studying the competence of the valvular system and the commun-

cating branches. The ascending technics allow exploration of the superficial and deep systems with or without tourniquets. The intravenous, transosseous, or arterial route may be used.

The transosseous serial technic gives ready information on the functional and anatomic state of the veins and shows whether the communicating vessels are adequate and whether the emptying is normal or retarded. A surgeon is not needed for this procedure, and it does not prevent the use of other descending technics when these are indicated. It can be repeated in the same patient, as opposed to phlebography by a catheter. The difficulty of entering a small vein in the foot is not encountered. While in some patients transosseous injection is painless, others suffer severe pain, which may necessitate slowing the rate of injection.

Either a commercially available trocar or a simple needle of 15 to 18 caliber is suitable for the procedure. The syringe should have a volume of about 20 to 30 c.c., with a metallic beak to prevent breaking under the pressure that is at times needed. The patient is fasting, and only local anesthesia is necessary. The needle is usually introduced by manual force, though at times a few taps with a small hammer may be required for perforation of the cortex. Care should be taken to prevent "ovalization" of the hole in the bone, since this favors reflux of the contrast medium into the subcutaneous tissues. While some workers favor injection in the supramalleolar region of the tibia, the present authors prefer the external surface of the calcaneus, a finger-breadth below the tip of the external malleolus. The needle or trocar is introduced approximately 1.5 cm. Five cubic centimeters of 1 per cent Novocaine is injected to lessen the pain. Next, 20 c.c. of the contrast medium is injected within ten to thirty seconds. A wide variety of organic iodides have been used by the authors. They prefer those of 50 per cent concentration.

A supramalleolar tourniquet is used in some cases. This is a useful device to make sure that filling of the superficial venous system results from insufficiency of a communicating vessel and not a superficial vessel of the foot. An elastic bandage may be used over the lower leg in order to obtain a better visualization of the deep veins in cases of insufficiency of the communicating vessels. The compression should not be excessive, lest the deep vessels be obstructed.

The position of the table is variable, but the authors prefer an angle of 45 degrees.

The usual time routine of making the exposures is immediately after the injection and at twenty, sixty, ninety seconds and two and three minutes. If the circulatory disturbance is pronounced, four- and five-minute films may be useful.

No significant reactions have been seen with transosseous serial phlebography. The roentgen findings in 12 patients are briefly discussed.

Forty-four roentgenograms; 2 drawings.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Functional Venography of the Lower Extremities.
Harris B. Shumacker, Jr., Thomas C. Moore, and J. A. Campbell. *Surg., Gynec. & Obst.* 98: 257-272, March 1954.

Previous venographic studies of the veins of the lower extremities have been difficult to interpret, and a review of the literature reveals a diversity of opinion on the

pathophysiology of venous disorders. Some have thought that regurgitation down the femoral and popliteal veins was an indication of disease, while others have postulated that this was a physiological process. In the evaluation of venous function in the lower extremities, the authors feel that muscular contraction must play an important role.

In an attempt to demonstrate their thesis, they made 115 venographic studies, 23 in normal persons and the remainder in patients with signs and symptoms of venous stasis, unexplained edema, or lymphatic blockade. The patient is placed on the x-ray table, which has been tilted 60 degrees toward the feet. Films are placed under the thigh, lower pelvis, and leg. Either 35 per cent Diodrast or 50 per cent Neo-Iopax is slowly injected intravenously. Exposures are made immediately following the injection and again about one minute later, after the patient has exercised by raising himself on his toes ten times.

In a high percentage of normal as well as abnormal subjects, retrograde flow of the radiopaque material into the distal portions of the femoral and popliteal veins was observed when the lower extremities were at rest and dependent. Following exercise these deep vessels became clear and it is concluded that such regurgitation in quiet dependency is not pathologic and hence not an indication for ligation or surgical interference.

In patients with recanalized veins following earlier thromboses or similar diseases, regurgitation also occurs, and these veins also clear following exercise.

The routine use of functional venography is not advocated, but such studies are useful in problem cases with venous stasis and may aid in the determination of the best therapeutic approach.

Fifty-eight roentgenograms.

DAVID J. STEPHENSON, M.D.
University of Pennsylvania

Visualization of Valvular and Myocardial Calcification by Planigraphy. Louis A. Soloff, Jacob Zatuchni, and Herbert Fisher. *Circulation* 9: 367-370, March 1954.

Since the presence of calcification in a heart valve is indicative of pathology, the authors have sought the best means of demonstrating the calcium shadows by comparing the results of (1) conventional roentgenography, (2) roentgenographic study with the Potter-Bucky diaphragm, (3) coning with fast exposures, (4) fluoroscopy, and (5) planographic study. An analysis of 13 consecutive cases showed planigraphy to be the superior method both from the point of view of the number of persons in whom calcification was demonstrated and the facility with which the condition was recognized. Fluoroscopy is a close second when done by persons who have a knowledge of the subject and are well adapted to the dark.

Planigrams were obtained in right anterior oblique or left posterior oblique and left lateral projections. Investigations are in progress to determine the optimum projection for the demonstration of specific intracardiac or vascular calcification.

The main significance of the procedure lies in the discovery of calcification in the aortic valve of patients being considered for mitral valve surgery.

Four roentgenograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Circulation Time: A Densometric Study. Björn Nordenström. *Acta radiol.* 41: 209-224, March 1954.

The author presents an experimental study in dogs of the effect of temporary occlusion of a pulmonary artery on the circulation time in the contralateral lung. The method of occluding the artery has been previously published (*J. Thoracic Surg.* 22: 527, 1951. *Abst. in Radiology* 59: 595, 1952). Here the electrokymograph for determining the blood transit time is described and the experimental technic is outlined.

From the investigation, the author concluded that the transit time of small volumes of contrast medium through the pulmonary circulation was shorter when one pulmonary artery was occluded than when there was unobstructed circulation through both lungs. This phenomenon would seem to constitute an appropriate compensatory hemodynamic change, since it is essential that the minute volume be maintained even when one lung is removed from the circulation. The experiments provided indirect evidence suggesting that the pulmonary circulation adapts itself to occlusion of the pulmonary artery to one lung also through augmentation of the blood volume circulating through the contralateral lung.

Ten illustrations; 1 table.

CLAUDE D. BAKER, M.D.
University of Louisville

Atrial Septal Defect in Infants and Children. Robert B. Disenhouse, Ray C. Anderson, Paul Adams, Jr., Rosalind Novick, Joseph Jorgens, and Bertram Levin. *J. Pediat.* 44: 269-289, March 1954.

Twenty-one patients were studied in whom the diagnosis of atrial septal defect was established by cardiac catheterization. Four of the number were infants and the remainder were between the ages of two and sixteen years. A survey of 202 postmortem examinations on children with congenital heart disease disclosed, in addition, 6 cases, all in infants, in which the atrial defect appeared to be the primary cause of death.

The principal symptoms in the infants were feeding difficulties, recurrent respiratory infections, and growth retardation; in the older children, respiratory infections, exertional dyspnea, and decreased exercise tolerance. Cardiac failure may occur early in life.

In the typical case, the physical examination disclosed increased precordial activity, displacement of the apex beat to the left, a systolic murmur in the first, second, and third interspaces, and an accentuated second pulmonic sound. The electrocardiogram frequently revealed right axis deviation and right ventricular hypertrophy.

Roentgenographic and roentgenoscopic examinations typically showed enlargement of the right atrium and right ventricle, dilatation of the pulmonary artery, and a small aortic knob. In no patient was enlargement of the left atrium noted. In general there was no relationship between the heart size and the clinical condition of the older patients. All the infants, however, had greatly enlarged hearts and were symptomatic. The pulmonary artery was prominent in every case, and the hilar and peripheral pulmonary vascular markings increased in all but one. Pulmonary artery dilatation was unusually marked in the infant group.

Cardiac catheterization appears to be the best method of substantiating the diagnosis during life. The diagnosis was made by demonstrating a rise of oxygen

content of at least 1.9 volumes per cent from superior vena cava to the right atrium and by passing the catheter through the defect into the left atrium and out a pulmonary vein. The authors have found a catheter to pass through the defect in approximately 50 per cent of cases.

Six roentgenograms; 4 tables.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Massive Dystrophic Calcification of the Myocardium. Irving I. Lasky. *Ann. Int. Med.* 40: 626-631 March 1954.

Massive calcification in myocardial infarcts is relatively uncommon. The condition produces a characteristic clinical picture and may be demonstrated by standard radiologic techniques. The diagnosis is of some prognostic import, since these patients, like others with coronary heart disease, are prone to sudden death.

Dystrophic calcification is the term applied to the laying down of calcium in dead, degenerated, or devitalized tissue, as in infarcts. This constitutes the most common type of pathologic calcification and is not associated with abnormalities of calcium or phosphorus metabolism *per se*. It can occur without changes in the circulating blood calcium content. Metastatic calcification, on the contrary, is associated with increased availability of calcium, occurring in association with bone-destructive lesions, parathyroidism, hypervitaminosis D, and renal insufficiency.

Approximately 21 cases of dystrophic myocardial calcification have been reported in the literature. With one exception, all of the 21 patients were males. The fact that calcium was deposited in the scar indicates that the infarct had occurred in the distant past. The shortest interval between infarction and the discovery of myocardial calcification in the reported cases was approximately six years.

The author's patient was a fifty-two-year-old white male in whom the primary myocardial lesion occurred approximately twenty-one years prior to the finding of the calcification. In the meantime the patient had lived an active life, with little evidence of physical impairment. The electrocardiogram showed changes corresponding to the area of myocardial damage and calcification. Fluoroscopy revealed a large oval calcification measuring approximately 5 X 7 cm. in the apex of the heart. Laminographic studies defined the position at the level of the left ventricle, approximately midway between the anterior and posterior diameters of the mediastinum. The unusual duration of physiologic normalcy following the original infarction and calcification is somewhat spectacular.

Whenever a history of myocardial infarction is obtained, a roentgenographic study seems amply justified. The latter should be performed in all cases of suspected heart disease, known heart disease, and cardiac enlargement, and in all patients over sixty.

Two roentgenograms; 1 electrocardiogram.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Anomalies of the Aortic Arch and the Vessels Originating from the Arch. F. Grosse-Brockhoff, H. Lotzkes, A. Schaede, and P. Thurn. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 314-329, March 1954. (In German)

Anomalies of the aortic arch and of the vessels orig-

inating from it have been described in less than 1 per cent of anatomic studies. Most of them are of no clinical significance. However, as they are often found in congenital heart disease, their exact anatomical location and description become extremely important in cases in which surgery for the latter condition is contemplated. For practical purposes the authors have divided the anomalies into three groups: those occurring in a left-sided aortic arch, those connected with a right-sided aortic arch, and those characterized by a double aortic arch. Available to radiologists for the study of these anomalies are the plain x-ray film, the kymogram, the esophagogram, and the angiogram. The question of right-sided or left-sided aortic arch can often be determined by the plain roentgenogram. Anomalies of the cervical vessels frequently produce an indentation visible in the esophagogram, but the most complete information is usually obtained from the angiogram.

In cases of a normal left-sided aortic arch the anomaly most often found is a displacement of the right innominate artery toward the left. The authors describe 2 cases and demonstrate how the right innominate artery, originating from the left aortic arch or even from the descending aorta, crosses over toward the right side between the trachea and the esophagus and produces an indentation in the barium filling of the esophagus as seen in the oblique view.

A right-sided aortic arch may show a mirror image reversal of the origin of the cervical vessels. There may be a left innominate artery and on the right side there may be a separate subclavian artery and a separate common carotid artery. As the arch is on the right, the left cervical vessels must cross over. They often do so anteriorly to the trachea. Sometimes, however, the left-sided cervical vessels take their origin distally to the right-sided cervical vessels and cross over behind the esophagus, causing a definitely demonstrable indentation in the barium filling along the posterior esophageal wall. The aorta may go straight down into the abdomen or it also may cross over posteriorly to the esophagus and then take a course to a left-sided diaphragmatic hiatus. Such a course (arcus circumflexus) usually produces a broad indentation in the posterior outline of the esophagus.

A double aortic arch usually takes one of two forms, either the arch is divided into two equally wide branches, of which one descends on the right side and one on the left side, or there is a common ascending aorta, which then divides, the main branch taking the course of a normal left-sided arch while a second branch (arcus circumflexus) goes around the esophagus from the right side and then joins the descending aorta. A well illustrated case of the first type is presented.

Thirty-three roentgenograms; 6 drawings.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Dilatation of Major Azygos Vein Simulating a Mediastinal Tumor. A Case Report. W. Robert Schmidt. *J. Thoracic Surg.* 27: 251-254, March 1954.

The author reports a case in which a dilated azygos vein was mistaken for a mediastinal cyst or tumor. X-ray examination in the postero-anterior, lateral, and oblique projections revealed a shadow of uniform density to the right of the mediastinum, at the level of the major azygos vein immediately posterior to the trachea. The mass did not show expansile pulsations. Opera-

tion revealed a dilatation of the major azygos vein, measuring 5 by 6 cm. The vein was ligated and divided, and postoperative films showed disappearance of the mediastinal shadow.

The azygos vein leaves the posterior thoracic wall at the inferior border of the fourth dorsal vertebra; it then curves inferiorly to the right, with the concavity of the curve to the left, and passes laterally to the esophagus and trachea and then medially to empty into the superior vena cava. The entrance into the superior vena cava is slightly lower than the point at which the vein leaves the posterior thoracic wall. Because of the curved course, the central portion of the vessel is best shown on a sagittal view, the posterior portion on the left anterior oblique, and the anterior portion on the right anterior oblique.

No cause for the dilatation of the vein in the author's case was found. Increase in size may be demonstrated occasionally in portal stasis and in conditions giving rise to increased pressure in the vena cava. Valsalva tests should show an increase in the size of the azygos vein. In large veins such as this one, planigrams would be of value in determining the nature of the lesion.

Four roentgenograms. R. G. FORTIER, M.D.
St. Paul, Minn.

Phlebographic Findings in Cases of "Venous Occlusion of the Upper Extremity" (Paget-v. Schroetter Syndrome). J. Drewes. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 341-354, March 1954. (In German)

Paget-v. Schroetter's syndrome or "venous occlusion of the upper extremity" is a more or less acute occlusion of the subclavian or axillary vein in an otherwise healthy patient. It is known also as intermittent venous claudication, primary thrombosis of the axillary vein, traumatic thrombosis, non-traumatic venous occlusion of the upper extremity.

The syndrome occurs for the most part in patients between the twentieth and fortieth year, more often in men than in women, and more often in the right arm than in the left. Trauma to the shoulder is seldom the cause of the onset; more frequently the condition occurs after strenuous or prolonged use of the arm, though cases have been reported in which there had been no such strain. Care must be taken to exclude from this group all those cases in which a definite mechanical occluding factor can be demonstrated, such as axillary lymph swelling due to tumor metastases or inflammation, substernal struma, aneurysm of the aorta or of the innominate artery, hematoma, scars, etc.

The etiology of this syndrome is still doubtful. Some attribute it to an overstretching of the vein causing a tear in the intima, with subsequent thickening of the wall of the vein leading to obstruction. Most writers believe that a definite thrombosis will form. Others feel that the syndrome may be caused merely by severe spasm in the subclavian vein. The author was led to this latter assumption because in the course of angiography he has occasionally encountered a severe spasm of the vein at the level where the first rib is seen to cross the clavicle on the films, blocking the flow of the contrast medium. That the obstruction was not organic could be proved by introduction into the vein of a catheter, which passed through to the heart.

Clinically the outstanding symptom is a swelling of

the arm, which may attain a circumference up to 7 cm. greater than that of the other arm. The swelling is mostly located in the upper arm, but it may extend over the entire member and sometimes involve even the shoulder and the neck. It is rather hard and the palpating finger cannot produce a lasting indentation. The color is blue or bluish-red, uniform or spotty. A noticeable dilatation of the superficial veins occurs only after several days and is an indication of beginning repair. The pain is usually not very severe, but paresthesia is often present. Sometimes in the axilla a heavy cord can be felt, which may be the thrombosed axillary vein. The venous pressure is definitely increased. Slight elevation of temperature may occur. The sedimentation rate is mostly not increased, and the blood picture is usually normal.

The author has observed 9 cases of the syndrome. In all of them phlebographic examinations were made and the site of the occlusion could be definitely demonstrated. Two methods were used. At first a catheter was inserted into the vein until it reached the obstruction and radiopaque material was injected. Later on, when a serial radiographic device that permitted the taking of five films in one second was obtained, the catheter was omitted. A constant and characteristic sign in the phlebograms was a partial or complete block of filling of the subclavian or axillary vein. In every case a well developed collateral venous circulation could be demonstrated, while in a normal venogram such a collateral circulation does not appear on the films because the medium proceeds along the line of least resistance directly into the heart. The point of obstruction is almost always at the same place, near the crossing between the first rib and the clavicle. Sometimes a fine filiform extension of the contrast substance can be seen to go through a thrombus, suggesting some canalization. Of the author's 9 patients, 5 were operated upon, and in 3 a segmental resection of the subclavian vein was done. The macroscopic appearance of the resected specimen was that of a thick-walled narrowed vessel. The microscopic examination showed in 1 case a freshly organized thrombus, and in 2 cases old canalized thrombi.

Sixteen roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

THE DIGESTIVE SYSTEM

Atresias and Congenital Stenoses of the Esophagus (Peculiarities of the Method of Examination and Clinical Points of View for the X-Ray Diagnosis). P. Ganz, H. Vieten, and K. H. Willmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 329-341, March 1954. (In German)

Congenital stenoses of the esophagus are relatively rare. They may be tube-like, extending over a fairly long section of the esophagus, or valve-like, consisting of a shelf-like indentation on one side. Atresias (congenital occlusions) are more common. There may be complete absence of the esophagus, but this fortunately is quite rare. Relatively common is the absence of a portion of the esophagus in the mid-section. This may take several forms. The proximal segment may be a closed sac, terminating at the level of the second, third, or fourth dorsal vertebra. The distal segment may show various stages of development. Sometimes the proximal segment is linked to the trachea or to a main

bronchus by means of a fistulous tract. Again, the distal segment may show such a fistulous communication, and still again two such fistulas may be present. Since these anomalies of the esophagus have recently become more amenable to radical surgery, their radiological demonstration has become clinically important.

The clinical symptoms of the congenital stenoses vary with the degree of narrowing. Sometimes liquid passes through freely, and the condition becomes clinically manifest only when the child begins to take solid food. Sometimes the diagnosis is first made in adolescence when, due to strenuous exercise, a spasm of the esophagus develops, causing dysphagia. The diagnosis is easily made and the congenital character of the stenosis can be established from the longitudinal folds, which are never present if the stenosis is due to scar formation following the swallowing of acid or lye.

Atresia of the esophagus becomes manifest in the first hours of life. The food is immediately regurgitated and the infant is subject to coughing spells and attacks of dyspnea. Within a short time a pneumonia may develop due to the aspiration of milk. Atelectases of various sections of the lungs, and sometimes a spontaneous pneumothorax, may be observed. As the result of surgical treatment depends on early recognition of the condition, before pulmonary complications have set in, the diagnosis must be made promptly.

The x-ray examination in cases of atresia should evaluate first the condition of the lungs (pneumonia, atelectasis, etc.), second the condition of the esophagus, and lastly the presence of any congenital anomalies involving the cervical and upper dorsal spine, etc. The administration of barium sulfate or of iodized oil is inadvisable, because these substances will eventually enter the lungs and produce serious complications. The author uses only water-soluble iodine preparations (Perabrodil-M, 45 per cent). This substance is completely absorbed within short time and is not likely to cause pneumonia. The infant is first placed on the table in a Trendelenburg position. A thin catheter is introduced into the nose and then into the esophagus as far as it will go. By means of suction all mucus is aspirated. The table is then tilted so that the child is in a more upright position, and under fluoroscopic control a small quantity (2 to 3 c.c.) of the medium is injected into the catheter by means of a syringe. Films are obtained in various positions. An atresia of the upper segment of the esophagus will be recognized by a meniscus-like lower border of the contrast medium, outlining the lower end of the esophageal sac. Sometimes a small fistulous track going into the trachea or into one of the main bronchi can be demonstrated. A film of the abdomen is then obtained. If this shows gas in the abdomen, it is an indication that a lower segment of the esophagus of considerable length must be present, and that a fistulous opening between this and the trachea or a main bronchus exists. This information is of great value to the surgeon, since he then knows that he has to bridge only a relatively small area between the two segments by anastomosis. If no gas is found in the abdomen, there may still be a fairly long esophageal segment present, but no definite statement can be made from the radiological examination, and the surgeon must be prepared to pull the stomach or some loop of the intestine up into the mediastinum for anastomosis with the oral segment of the esophagus, if this should prove necessary.

In the differential diagnosis, the only condition that may have to be considered is a diverticulum. If a well founded suspicion of a diverticulum exists, the diagnosis should be made by a direct esophagoscopy. Otherwise an esophagoscopy should be avoided.

If a surgical end-to-end anastomosis is done, a post-operative x-ray examination should be postponed for at least eight to ten days. It should be made, however, before the usually performed Witzel gastrostomy has been allowed to close. If the infant is able to swallow, a thin barium sulfate mixture may be used for examination of the anastomosis.

The author has studied 25 cases of atresia which he presents in tabular form.

Thirteen roentgenograms; 1 drawing; 1 table.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Peptic Esophagitis. Gordon M. Carver, Jr., and W. C. Sealy. *Arch. Surg.* 68: 286-295, March 1954.

Peptic esophagitis is an inflammatory process which occurs as the result of a persistent association of gastric or intestinal secretions with the non-resistant squamous mucosa of the esophagus. The authors report 130 cases. Ninety-eight of these were found to be associated with hiatus hernias. Seventeen arose following surgical excision or destruction of the cardiac sphincter for carcinoma or other cause. Fifteen cases occurred in patients with a history of persistent vomiting, usually caused by duodenal ulcer. The authors believe that the short esophagus which is so frequently found with a hiatus hernia is not congenital but is usually an acquired condition, the result of peptic esophagitis. They do not consider ectopic gastric mucosa a significant etiologic factor in esophagitis.

In the series of cases here reported, dysphagia was the most frequent symptom, occurring in 77 per cent of the patients. Substernal pain or "heartburn" was present in 70 per cent, regurgitation in 40 per cent, weakness in 30 per cent, and hemorrhage in 10 per cent. The diagnosis was made in all instances by x-ray examination, which showed areas of constriction, sometimes smooth and sometimes irregular. To rule out carcinoma, esophagoscopy was performed on most patients.

Treatment of the condition varied according to the stage of the disease. Forty-seven of the patients were considered to have an acute esophagitis and were treated by medical measures. These include elevation of the head of the patient's bed on 8-inch blocks, a diet consisting of three liquid or semisolid meals each day, a glass of water after each meal, antacids, atropine before meals, parasympatholytic agents, and antibiotics to reduce secondary bacterial infection.

Seventy-four patients were considered to have esophagitis with chronic ulceration and stricture. They were treated by the conservative measures used for acute cases, *plus* oral dilatation of the esophagus with bougies. In a few instances the strictures were so severe as to necessitate gastrostomy and the use of retrograde dilatation of the esophagus.

Nine patients had chronic esophageal ulceration with stenosis.

The authors prefer esophagojejunostomy for treatment of esophageal strictures, because the postoperative morbidity is lower. They recommend early repair of sliding hiatus hernia when esophagitis does not respond completely to medical management. Three of their pa-

tients had esophageal ulcer, hiatus hernia, and duodenal ulcer. They point to this combination as a relatively malignant triad, which should be treated by subtotal gastric resection and repair of the hiatus hernia.

Four roentgenograms; 3 tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Peptic Esophagitis with Duodenal or Gastric Ulcer. Asher Winkelstein, Bernard S. Wolf, Max L. Som, and Richard H. Marshak. *J.A.M.A.* 154: 885-889, March 13, 1954.

The authors discuss a type of esophagitis which is found associated with hyperchlorhydria and peptic ulcer of the duodenum or stomach. Esophagitis due to other causes, such as hiatus hernia, severe vomiting, prolonged intubation, operative anastomosis to the stomach, and solitary peptic ulcer is not included in their series of 20 cases.

The disease is uncommonly reported, perhaps because esophagoscopy is not often done for mild symptoms. Eleven of the authors' patients were over sixty years old; 8 were between forty and sixty. Males were predominant, 19 to 1. Symptoms, in order of frequency, were dysphagia, heartburn, regurgitation and/or vomiting, substernal pain, weight loss, and hemorrhage. Hyperchlorhydria (over 40 units free acid) was noted in 85 per cent of the series.

The chief complications were stenosis, hemorrhage, and perforation. Stenosis may be due to inflammatory swelling, spasm, fibrous stricture, or to a combination of these factors. Hemorrhage, in the 3 cases in which it occurred, took the form of hematemesis, and in any case of bleeding of the latter type peptic esophagitis should be considered. Perforation occurred in 1 case.

Fifteen patients had a coexistent duodenal ulcer, 2 had gastric ulcers. A gastric ulcer in one patient and a duodenal ulcer in another patient developed after the esophagitis. One patient had previous solitary peptic ulcer of the esophagus. Five patients had small hiatus hernias, probably secondary, due to traction by a shortened esophagus. Pyloric obstruction was present before dysphagia in only 1 case.

Radiographically, there are changes in distensibility or narrowing of the lower third of the esophagus and an altered mucosal pattern. The narrowing is gradual and symmetrical. The mucosa may be irregular, but discrete ulcers are not seen. There is no peristalsis. Early cases will not show narrowing, but merely lack of distention and indistinct mucosal pattern. A phrenic ampulla is not seen.

The differential points suggesting a marginal ulceration just above a large hiatus hernia, as against this type of peptic esophagitis, are: short esophagus; short area of involvement of distal esophagus with normal esophagus above; discrete ulcer crater; prompt and marked transcardial reflux.

The gross and microscopic pathology is discussed in detail, the latter showing changes generally accepted as evidence of peptic inflammation. Medical therapy with a Sippy regime, anticholinergic drugs, and dilatations is usually adequate. The authors' results with surgery in 6 cases (transthoracic bilateral vagotomy, alone and with gastroenterostomy; subtotal gastrectomy) were disappointing.

Sixteen patients in this series have done well; 3 still had symptoms after four to ten years, and 1 died of a perforation.

Carcinoma is the most important consideration in differential diagnosis. Biopsy is imperative to rule this out.

Five roentgenograms; 1 photomicrograph.

JOHN P. FOTOPoulos, M.D.
University of Michigan

Gastric Motive Function, with Particular Reference to the Activity of the Conducting System in the Stomach. Bengt Lilja. *Acta radiol.* 41: 225-246, March 1954.

The author is interested in the activity of the conducting system in the stomach. In 1953 he demonstrated a characteristic disturbance of gastric motility in cases of severe ulceration in or near the incisura angularis, for which he suggested the designation "gastric block" (*Acta radiol.* 39: 353, 1953. *Abst. in Radiology* 62: 452, 1954). Here he reports 11 cases of gastric ulceration of the longitudinal stomach to illustrate the roentgenologic signs. He believes that more detailed studies are indicated for the demonstration of disorders of gastric motility. For this purpose, he advises that the stomach be not overloaded with a heavy contrast medium, that the patient be examined in the supine as well as the erect position, and that manual manipulation be avoided, as this tends to interfere with motility. He emphasizes, also, more careful study of the uppermost part of the stomach, for ulcers in this area will cause irregularity in the lower portion.

A description of the three layers of muscle of the stomach wall is given, including the physiological action of these layers in the presence of ulceration of the longitudinal portion of the stomach.

The triad of roentgenologic signs in the inferior part of the longitudinal stomach occurring with ulceration of the lesser curvature consists of (1) inward bulging on the greater curvature with constriction of the lumen; (2) folds radiating from the ulcer; (3) increased "gastritis-like" serrations of the contour of the greater curvature. This triad is attributed to the contraction of the inner muscular layer beneath the ulcer. Any involvement of this inner muscular layer will cause shortening and decrease in the width of the longitudinal portion of the stomach, and impairment of the gastric motility will persist even after healing. Contractions or spasms occur below the site of ulceration following impairment.

The author feels that the inciting muscle, namely the inner muscular layer, along with the motor center in the incisura angularis, as observed in the earlier paper, comprise a conducting system which regulates the motility of the stomach.

Twenty-one roentgenograms; 3 drawings.

JOHN F. BERRY, M.D.
University of Louisville

Congenital Pyloric Stenosis at the Boston City Hospital. Martin J. English, John H. Crandon, Max Ritvo, and Gerard Desforges. *Arch. Surg.* 68: 271-281, March 1954.

In an effort to lessen the mortality rate from hypertrophic pyloric stenosis a program was instituted at the Boston City Hospital which assigned to one team of surgeons all operations for this condition in infants and placed the patients on the pediatric service throughout their hospital stay. In a three-year interval under this regime, 41 infants were operated upon. In 37 the preoperative diagnosis was pyloric stenosis, and in

34 of these the diagnosis was confirmed. In the other 3 the final diagnoses were, respectively, malrotation with duodenal compression, pyloric compression by a congenital band continuous with the round ligament of the liver, and duodenal constriction secondary to a cholecystoduodenal band with pyloric angulation. In the latter 2 cases it was impossible to determine whether a band or pylorospasm was the obstructing agent, and in each instance, therefore, the band was divided and a Ramstedt procedure then performed.

Of the 4 patients without preoperative diagnoses of pyloric stenosis, 2 were considered to have pylorospasm, 1 "intestinal obstruction," and 1 "probable malrotation." At surgery, the 2 latter patients were found to have pyloric stenosis, and were treated by pyloromyotomy, as were all of the others having that condition. The 2 preoperative diagnoses of pylorospasm were confirmed by surgery. Pyloromyotomies were performed upon these 2 infants as an investigative maneuver, with a good result in 1 instance and equivocal outcome in the other. The authors believe that the Ramstedt operation should be attempted in instances where the diagnosis of pylorospasm is established by exclusion, and when the patient's condition remains refractory to medical management.

The age range in this series is wider than that usually reported (three days to four months). A higher proportion of females than usual was encountered—33 per cent in contrast to percentages of 10 to 20 previously reported for other series.

The duration of symptoms ranged from three days to five weeks. In cases where the diagnosis was clear-cut, a minimum of time was utilized in establishing fluid and electrolyte balance prior to surgery. Longer periods of study were found necessary when the diagnosis was in doubt. Therefore, the preoperative period in the hospital varied from one to thirty-three days. The postoperative stay ranged from twelve to fifty-eight days, averaging twenty days; hospital convalescence was prolonged until all sutures had been removed and until the infant gained in weight. In some instances the length of hospitalization was extended because of unsatisfactory home conditions.

The unequivocally palpable pyloric tumor which has been described as being present in 90 to 95 per cent of cases was found in only 17 of the 36 proved cases. X-ray studies with barium were carried out on 23 patients. Elongation of the pyloric canal, with or without a "string sign," and smoothly rounded filling defects either in the prepyloric portion of the stomach or at the base of the duodenal bulb were considered very significant. In some instances, however, the ingested barium mixture was first seen to pass through a relatively normal appearing pylorus at a normal rate. The most outstanding finding was markedly delayed gastric emptying: 75 per cent of the meal might remain in the stomach after six hours, and a large residue might still be present after twenty-four hours. The patients with pylorospasm exhibited no such retention.

Four photographs; 2 roentgenograms.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Ten O'Clock Meal in School. O. Wild. Schweiz. med. Wchnschr. 84: 298-303, March 6, 1954. (In German)

The ten-o'clock school meal, or second breakfast, is useful only if it is of high nutritional value and does not

overload the stomach. The author checked on previously made claims that milk is retained in the stomach longer than other food and that a barium-milk mixture shows a two-and-a-half-hour retention roentgenologically while ingested apples are supposed to leave the stomach much sooner.

In 194 school children tested with various foods, the response to apples varied widely, showing retarded as well as rapid emptying. In only one-third of the cases did the "apple stomach" empty more rapidly than the "milk stomach." The milk was retained in the stomach on an average of two hours. It was also observed that when food residue was present, milk stimulated digestion.

In conclusion, the author sees no reason for abandoning milk for the ten o'clock meal, or for giving apples or other fruit instead.

Twenty roentgenograms; 11 graphs; 2 tables.

ERNEST KRAFT, M.D.
Newington, Conn.

Roentgen Investigations of the Neo-Natal Gaseous Content of the Intestinal Tract. Johan Frimann-Dahl, John Lind, and Carl Wegelius. *Acta radiol.* 41: 256-268, March 1954.

The authors made a study of gas in the intestinal tract based on roentgen examination of 20 living newborn infants and 15 seen postmortem. They conclude that gas does not collect in the stomach or intestines during intrauterine life, but appears immediately after birth, simultaneously with the expansion of the lungs. It originates from the swallowing of atmospheric air. In stillborn infants there is no visible air in either the lungs or the intestinal tract. If the infant is undeveloped or feeble, it may live for some hours without gas being demonstrable in the lungs or stomach. If pulmonary breathing is inhibited and the lungs are atelectatic, the air may penetrate into the stomach, thereby giving a definite proof of life. The authors present 1 case in which the lungs were filled with air while no air could be detected in the stomach or bowel.

Gas traverses the small intestine and reaches the colon at a fairly constant speed in healthy newborn infants and can serve as evidence of life on roentgen examination. In a full-term healthy child, air appears in the stomach and lungs simultaneously, immediately after birth, and fifteen minutes later the gas bubble is increasing in size and is filling the viscus. In thirty minutes air is visible in the duodenum and jejunum and may have reached the proximal portion of the ileum. After one hour the air bubble in the stomach may have decreased a bit in size but, on the other hand, gas has been propelled further and has reached the terminal ileum. In two hours the air has traversed the small intestine and may have reached the cecum. After three hours a physiologic meteorism has usually developed. Between two and three hours variation of the gaseous content of the colon may be observed.

The authors found that, even though the lungs appear completely atelectatic on the roentgenograms, in certain cases air may be revealed microscopically, or part of the lungs may float in water. The roentgenologic demonstration of air in the stomach and intestines seems to be more accurate and reliable than in the case of the lungs.

The authors emphasize the importance of roentgen examination in postmortem and forensic cases for the

presence of and the progression of air in the lungs and intestinal tract.

Twenty-four roentgenograms; 1 table.

CLAUDE D. BAKER, M.D.
University of Louisville

The Roentgen Findings in Strangulating Obstructions of the Small Intestine. Harry Z. Mellins and Leo G. Rigler. *Am. J. Roentgenol.* 71: 404-414, March 1954.

The differentiation between strangulated obstructions and simple obstructions of the small intestine is of great importance. Many simple obstructions could be treated conservatively if it were certain that no strangulation existed.

An obstruction is considered to be of the strangulating type if, in addition to a block in intestinal continuity, there is evidence of compromise of the blood supply. In most cases of internal strangulating obstruction, a closed loop is produced. This occurred in almost 60 per cent of a series of 26 cases studied by the authors.

If the twisted loop is partially closed, it will be filled with gas or gas and fluid. On the horizontal film the gas shadows of the two limbs of the loop will show separation by thickened intestinal wall or fluid. This is called the "coffee bean" sign. If the loop is completely closed, there will be little or no gas and the loop will now show as a rounded soft-tissue density—the "pseudotumor" sign. A third sign to be looked for is fixation of the involved loop. Films made in the erect, supine, and lateral decubitus positions will show lack of movement of the involved loop. A fourth finding is loss of the normal mucosal pattern in the involved loop.

It must be remembered that strangulating obstruction can occur without evidence of abdominal distension. Therefore, there may be no evidence of gas above the region of obstruction. It should also be noted that a strangulated loop of bowel may transport gas and fluid, and that gas may thus be found in small amounts in the colon.

Several accessory roentgen signs are described. Among these are (1) inability to decompress a localized loop following suction and (2) distention of a segment of intestine out of proportion to the remaining loops.

Seventeen roentgenograms; 1 table.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Early Recurrent Acute Intussusception in Children. David A. Macfarlane and L. P. Thomas. *Brit. M. J.* 1: 559-560, March 6, 1954.

The incidence of acute intussusception was found by Spence and Court (*Brit. M. J.* 2: 920, 1950) to be 3.8 per 1,000 births. Recurrence of acute intussusception occurs much less often. Thorndike (*New England J. Med.* 207: 649, 1932) reported 5 cases and found 75 others in the literature. The authors describe 4 cases with recurrence four, five, six, and eight days, respectively, after operation.

The importance of early diagnosis based on clinical and radiological findings is emphasized. The treatment is surgical.

R. F. LEWIS, M.D.

Cleveland Clinic

Intestinal Obstruction Due to Swallowing of Air. Report of a Case. William Trevor. *J.A.M.A.* 154: 832-833, March 6, 1954.

This is believed to be the only case in the world litera-

ture of partial obstruction of the descending colon due to swallowing air. It occurred in a patient who had undergone a total laryngectomy and was using esophageal speech, necessitating the swallowing of quantities of air to be eructated so that the sound could be converted into speech by the lips, teeth, tongue, and palate. A barium enema examination showed the point of obstruction with large gas-filled loops of colon and small bowel proximally. The mechanism of the obstruction is explained by the fact that, owing to increasing distention of the proximal descending colon, the sigmoid folded over on itself near its peritoneal attachment, thus completing the mechanical intestinal obstruction.

Two roentgenograms.

JOHN P. FOTOPOULOS, M.D.
University of Michigan

Pneumatosis Cystoides Intestinalis: Report of a Case. Gordon W. Briggs, Ramon A. Sifre, and Edwin L. Overholt. *Ann. Int. Med.* 40: 618-626, March 1954.

Pneumatosis cystoides intestinalis is an uncommon condition characterized by multiple gas-containing cysts in various portions of the gastrointestinal tract. The two most acceptable theories as to the origin of the gas attribute it to (1) mechanical causes and (2) dietary deficiency. According to the mechanical theory, generally accepted, the gas is forced into lymphatic channels distending lymphatic spaces. The deficiency theory has some support in the fact that a large number of patients have pronounced digestive disturbances secondary to associated diseases.

The cysts are usually located in the small bowel, more commonly on the antimesenteric border of the serosa. They occur also in the large bowel and have been reported in the stomach and in the mesentery. They may be predominantly subserosal, varying greatly in size, or may be chiefly mucosal, in which case they are small and more uniform, producing a soap-bubble or honeycomb appearance. Again, they may be distributed in all layers of the bowel wall. The composition of the gas has not been satisfactorily determined. Microscopically the cysts are empty except for occasional small amounts of serous-like fluid. An inflammatory and foreign-body type of reaction with giant cells of the mononucleated type is reported in association with the cysts, as well as acute and chronic inflammatory cells with fibrosis.

The majority of the cases are associated with mucosal ulceration and obstruction of the alimentary canal. Other associated conditions include intestinal tuberculosis, chronic and acute appendicitis, intestinal obstruction due to gallstones, chronic colitis, and intestinal parasitism.

The roentgenographic findings, as described by Lerner and Gazin (*Am. J. Roentgenol.* 56: 464, 1946), consist primarily of translucent areas lying within the contour of the normal bowel. When a contrast medium, such as barium, is used, there is inability to completely fill out the lumen of the bowel, giving the impression of filling defects. The presence of inconstant filling defects of increased translucency is pathognomonic. There may also be spontaneous pneumothorax. Interposition of cyst-like lesions between the liver and the right leaf of the diaphragm may be demonstrable when the cysts are present in the small bowel, as in the single case reported here.

The disease has often been stated to be benign and self-limited. However, death due to obstruction has been recorded.

One roentgenogram; 1 photograph; 2 photomicrographs.

STEPHEN N. TAGER, M.D.

Evansville, Ind.

Pneumatosis Cystoides Intestinalis. E. Altstaedt and E. Fiedler. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 393-396, March 1954. (In German)

Pneumatosis cystoides intestinalis is a rare disease, only about 200 cases having been published so far. It is characterized by the appearance of cyst-like blisters in the submucosa of the colon and the small intestine, ranging in size up to the dimensions of a walnut or larger and containing air but no fluid. The etiology is not quite clear. Some authors assume an invasion of the submucous structures by a gas-producing bacterium, the so-called *Bacterium pneumatodes*, which is related to the *Bacillus coli*. Others believe that any colon bacilli may produce gas if the diet is sufficiently rich in carbohydrates and if certain other metabolic conditions are fulfilled. The disease may spread over the whole colon and the small intestine and may disappear spontaneously, with the formation of scars representing the individual cysts. Diarrhea and bloody stools are common.

The authors report the case of a thirty-two-year-old man who had been suffering intermittently for about two years from diarrhea, with stools containing mucus and blood. The blood count was normal. Proctoscopic examination disclosed an area of multiple hard, polyp-like protrusions covered with an inflamed reddish mucous membrane, beginning about 15 cm. above the sphincter. Between the protrusions the mucosa appeared to be normal. Roentgenologic examination showed the colon to have an eroded moth-eaten contour. After air inflation, a picture was obtained suggesting polyposis. The left half of the colon from the middle of the transverse colon down to the sigmoid was resected. The mucous membrane was covered with hundreds of cyst-like protrusions, ranging in size from a poppy seed to a walnut. When one of the cyst-like structures was punctured with a scalpel, it popped like a balloon and gas escaped. The patient made an uneventful recovery.

Within the walls of the cyst-like lesions, numerous large giant cells with dark nuclei were found, resembling foreign giant cells. They were particularly frequent in the smallest and therefore in the youngest cysts. Many eosinophilic leukocytes were present.

The authors believe that, inasmuch as Terramycin can practically sterilize *B. coli* in the bowel, every patient in whom the disease is suspected should have a trial of medical treatment.

One roentgenogram; 1 photomicrograph; 1 photograph.

WILLIAM A. MARSHALL, M.D.

Chicago, Ill.

Three Cases of Benign Tumors of the Duodenal Bulb. Antonio di Sieno. *Radiol. clin.* 23: 76-86, March 1954. (In Italian)

With the advent of the newer radiologic and surgical techniques, benign tumors of the duodenal bulb are no longer to be considered rare. They are divided into epithelial, muscular, connective-tissue, neural, vascular, and mixed tumors. They seem to occur for the most

part at about fifty years of age. While the majority are solitary, they are occasionally multiple. Their growth is regularly expansive, and because of this they are more or less grossly round, with regular sharp margins. They may be sessile or pedunculated.

Clinically, the benign tumors of the duodenal bulb do not present a characteristic picture. Radiographically, they are seen as round filling defects. Though visible with the bulb filled, often they are better demonstrated with graduated compression. The defect is regular and is "punched-out" when its surface is smooth and flat; however, it will be reticulated or spotty when the tumor is lobulated or mulberry-like. The presence of a pedicle can be determined fluoroscopically. Even the sessile tumors present a certain mobility, explained by the looseness of the mucosa upon which they are implanted. When the tumor is ulcerated, study of the surrounding mucosal pattern is especially important for differentiation from an ulcer crater, since in the former case the folds are not radiating.

The differential diagnoses to be considered radiologically are: foreign bodies, transpyloric prolapse of the gastric mucosa, impression of the pyloric muscle, extrinsic compressions, peptic ulcer, malignant tumors, tuberculoma, and aberrant pancreas.

In 20,000 examinations, the author found 3 cases of benign tumor of the duodenal bulb. The first was a myoma in a fifty-six-year-old man. Under fluoroscopic observation, the tumor defect disappeared with increased pressure, which was believed to displace it extrinsically. The second case was in a seventy-one-year-old man and was unproved, as the patient refused surgery. He responded to antispasmodics and radiographically showed no change in ten months. The third case occurred in a seventy-eight-year-old woman with intestinal bleeding and poor general condition. On exploration an adenoma of Brunner's glands was found.

Three roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Inverted Appendical Stump Simulating Cancer of the Cecum. Arkell M. Vaughn and Jerrold Widran. *J.A.M.A.* 154: 996-997, March 20, 1954.

The authors present a case in which an inverted appendical stump simulated carcinoma of the cecum. The patient was a thirty-nine-year-old woman who had had an appendectomy seven months before. Examination revealed a small palpable mass in the right lower quadrant of the abdomen, and a slight anemia. A barium enema study showed a filling defect in the cecum. Two weeks after the initial examination, the mass was no longer palpable but air contrast studies again revealed the filling defect in the cecum. At surgery the inverted appendical stump was found, but there was no evidence of neoplasm. A repeat barium enema examination six months later showed an absence of the previously irregular ragged defect in the cecum and a smooth filling defect at the operative site.

The authors list the following as the commonest conditions causing difficulty in roentgenographic differential diagnosis in the cecal region: fecal scybala, distortion secondary to an appendiceal abscess, regional ileitis, tuberculosis, cecal diverticulitis, amebic involvement of the cecum, ulcerative colitis, adhesions after appendectomy, and an inverted appendical stump.

Two roentgenograms. JOHN J. CRAVEN, M.D.
Cleveland Clinic

Annular Pancreas. Lee Gillette and Brock Lynch. *Ann. Surg.* 139: 374-378, March 1954.

Annular pancreas is a developmental anomaly having the following salient features: (1) congenital origin; (2) symptoms and signs of partial obstruction of the second portion of the duodenum; (3) predominance in males, in the ratio of 2 to 1; (4) onset of symptoms frequently in adult life. At operation the lesion appears as a napkin ring-like mass of glandular tissue seen to encircle the duodenum and to be directly contiguous to the head of the pancreas anteriorly and posteriorly. The authors review the literature and state that there is strong evidence in favor of the use of short-circuiting procedures in the surgical treatment. Duodenojejunostomy is advocated as the method of choice.

The diagnosis is not often made preoperatively, but it should be suggested by the typical extrinsic ring-like narrowing of the duodenum when it is opacified with barium. Since the symptoms have their onset primarily in adult life, careful examination of the duodenum should be a routine procedure in all examinations of the upper gastrointestinal tract.

Two roentgenograms; 1 photograph; 1 drawing.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Congenital Duplication of the Gallbladder. Review of the Literature and Report of an Unusual Symptomatic Case. Thomas C. Moore and Anson G. Hurley. *Surgery* 35: 283-289, February 1954.

Congenital duplication of the gallbladder may be either complete or partial. In cases of complete duplication the two gallbladders are entirely separated, without communication, and may or may not have separate serosal coverings. In these cases, there may be two complete cystic ducts, each entering the common duct with its own orifice, or the ducts may unite at a "Y" junction with a single opening into the common duct. In cases of incomplete duplication, the gallbladder may be bilobed or partially septate. Only 8 cases of incomplete duplication have been reported. The authors' case is the 36th of complete duplication to be recorded. Of this number, 9 were discovered postmortem and 27 at operation.

In the majority of cases, the symptoms have been those of cholecystitis and cholelithiasis. Seventy-five per cent of the patients have been women, and the age of onset of symptoms has ranged from nineteen to sixty-nine years, with an average of forty-three years. In approximately 75 per cent of the cases of complete duplication of the gallbladder, the cystic duct also has been completely duplicated, but in the remaining cases, the cystic ducts have joined to enter the common duct with a single opening. Although it occasionally has been possible to remove a pathologic gallbladder, leaving the normal one, the surgical management in the majority of symptomatic duplications has involved the removal of both gallbladders, either because both were diseased or because their relative intimate approximation prevented selective removal.

In the authors' case each gallbladder had a separate serosal covering. The proximal gallbladder was acutely inflamed and was removed. The distal one, which was normal in appearance and had been shown by cholecystography to function normally, was left behind.

Two roentgenograms; 1 drawing.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Residual Stones in the Common Bile Duct: The Question of Operative Cholangiograms. Edward V. Johnston, John M. Waugh, and C. Allen Good. *Ann. Surg.* 139: 293-301, March 1954.

This report is based upon the study of 153 cases of choledocholithiasis which were followed for at least two years. Excluded from the study were cases in which the predominant disease process was acute pancreatitis or stricture or tumor of the common bile duct and those in which exploration of the common duct was negative.

Adequate evidence of absence of residual stones was obtained in 127 cases. Persistent or recurrent complaints and postoperative cholangiograms suggested residual stones in 26 cases. In 12 of these the stones had been overlooked at the time of the initial choledocholithotomy. Repeated postoperative cholangiograms established the diagnosis in 2 of this latter group; in the remaining 10 cases the findings on postoperative cholangiography were positive in 9. A stone was visualized in the common duct in 5 instances; partial or complete obstruction of the common duct was present in 3, and a stone was seen in the left hepatic duct in 1 case. Reflux filling of the pancreatic duct was observed in all 3 cases in which there was some degree of obstruction of the lower end of the common duct. In the tenth case the cholangiogram was normal, but subsequent re-exploration disclosed a stone wedged in the ampulla.

In evaluation of recurrent symptoms following cholecystectomy, two important pathological processes must be considered: (1) inflammatory strictures or stenosis of the common duct resulting from previous impaction of stones at or near the ampulla of Vater and (2) recurring mild episodes of pancreatitis.

There are two situations which are important in causing stones to be overlooked or left in the ducts at the time of surgery: (1) Small stones may become imbedded in the crypts or in ulcerated portions of the wall of the common duct at or close to the ampulla of Vater. These are difficult to dislodge with probes or irrigating solutions and they may escape demonstration as discrete filling defects when radiopaque solutions are passed through the common duct. (2) Small stones can migrate into the hepatic ducts and their secondary radicles. These stones are often inaccessible to a probe. Hepatic stones are not often visible as negative shadows but must be diagnosed from indirect signs, such as absence of filling of one hepatic duct when the others are well filled. For this reason operative cholangiography requires multiple views.

Although operative cholangiography is of value in cases where residual stones are demonstrated, the technical shortcomings of the procedure seriously limit its value. It requires greater accuracy before it can replace surgical exploration by an experienced surgeon or become a routine part of choledocholithotomy.

Two tables.

RICHARD F. McCCLURE, M.D.
Redondo Beach, Calif.

HERNIA

Hiatus Hernia: The Problem of Diagnosis. Eddy D. Palmer. *J. Thoracic Surg.* 27: 271-276, March 1954.

The author reports a study of 82 cases of hiatus hernia proved by roentgenologic or endoscopic examination. All were of the direct or common type, with simple transhiatal displacements of the cardia and varying amounts of stomach. Roentgenologic examination was success-

ful in establishing or confirming the diagnosis in 78 per cent of the 82 cases, in 60 per cent on the first examination and in the remainder on repeated study.

Esophagoscopy was the most efficient diagnostic method, establishing a diagnosis or confirming it in 86 per cent of 51 patients; the first esophagoscopy was positive in 80 per cent. Gastroscopy was the least efficient, affording a diagnosis in 46 per cent. Seven cases of esophagitis were revealed only by endoscopy, and a few cases of esophageal diverticulosis were discovered radiologically.

In several controversial cases, the endoscopist put a metal brain clip at the junction of the esophagus and stomach. This junction was determined by the appearance of the mucosa and proved by biopsy at the site where the clips were placed. X-ray examination of these patients showed the clips to be lying superior to the hiatus. There were 8 such cases: in 4 the radiologist was able, at a second examination, to demonstrate a hernia; 2 of the others were treated medically and 2 were operated upon and a hiatus hernia was repaired. Reports of these last 2 cases are included.

The author emphasizes the difference in approach between the esophagoscopist and the radiologist. The esophagoscopist determines the esophagogastric junction by observing the point at which the gastric mucosa is visualized. The radiologist places this junction at the point at which the digestive tube lumen suddenly widens. The author feels that any point of the digestive tract covered by gastric mucosa contiguous with the mucosa of the stomach, as classically defined, represents stomach. The radiologist and the esophagoscopist are thus using different definitions of the disease hiatus hernia. An incompetent cardia may allow a retrograde reflux of gastric contents leading to esophagitis, ulcer stricture, fibrosis, and finally esophageal shortening.

The author concludes that, while esophagoscopic examination is more efficient in diagnosing hiatus hernia than either roentgenology or gastroscopy, all three methods are indispensable for the demonstration of esophageal and gastric complications.

Eight drawings; 3 tables.

R. G. FORTIER, M.D.
St. Paul, Minn.

THE MUSCULOSKELETAL SYSTEM

Osteopoikilosis and Its Radiologic Manifestations: An Unusual Aspect of the Spotty Variety. Luigi Ferri. *Radiol. med. (Milan)* 40: 263-272, March 1954. (In Italian)

Only about one hundred cases of osteopoikilosis had been reported up to 1950. Discovery of this condition is usually incidental; in the living, diagnosis is exclusively radiologic. Usually there are no clinical manifestations, unless one is willing to accept as such the vague pains in the bones and joints which frequently occur. The disease is familial and hereditary, either dominant or recessive. It is found at all ages, especially in adolescents and adults, and in males more frequently than in females. It is often accompanied by cutaneous and subcutaneous fibrous nodular hyperplasia, the so-called disseminated lenticular dermatofibrosis. Any bone may be involved, but with differing intensity and frequency. The sites of predilection are the epiphyses and metaphyses of the long bones, carpal bones, hands, feet, and pelvis. Three varieties are described: spotty, striate, and mixed.

In the striate variety, longitudinal, parallel, slender dense streaks, several millimeters thick, are demonstrable along the longitudinal axis of the bone, extending from the epiphyseal line into the metaphysis, for a distance of a few to eight or more centimeters.

The foci in the spotty variety appear as dense nodules of varying size: some are just barely visible; some are as large as a small nut. They are usually round or oval, but at times fusiform or lanceolate, especially those that are more distant from the epiphysis. They are found in greater number in the spongiosa, but are also present in the cortex. During the growth period, the nodules may increase in size, appear in new bones or elsewhere in the same bone, demonstrating a clear evolutive phase of the disease. These dense nodules have been shown histologically to be due to trabeculae of varying size heaped upon each other in varying disposition. The marrow spaces of the nodules communicate with the adjacent normal marrow. Arteriography has demonstrated definite diminution of the lumen of osseous vessels to these nodules.

There are three current theories of etiology of osteopoikilosis: (1) that it is a chondrodysplasia; (2) that it is of tuberculous origin; (3) that it is a constitutional condition.

The author reports in detail a case of the spotty type of osteopoikilosis in a twenty-one-year-old woman. The main interest of this case, aside from the extent and unusual localization of the spots, was the hitherto undescribed appearance of the sclerotic foci: several condensations were seen in the inferior metaphyses of both femora with a definite annular appearance. These regions were studied by laminagraphy, and the dense shells surrounding the cores of lesser density were clearly demonstrated.

Ten roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Difficulties in Early Diagnosis of Myositis Ossificans.
Leonard Weinstein, Samuel H. Fraerman, and Philip Lewin. *J.A.M.A.* 154: 994-996, March 20, 1954.

The authors report a case of myositis ossificans which closely resembled sarcoma. The patient, an eight-year-old boy, was first seen with pain in the left hip and a limp. There was no history of trauma. A few days later, swelling, pain, and tenderness developed over the anterior aspect of the left thigh, and a roentgenogram showed soft-tissue swelling and a faint periosteal elevation of the middle third of the femoral shaft. There was no evidence of cellulitis and no inguinal adenopathy. The temperature curve was of the septic type. Laboratory findings were non-contributory. The swelling progressively increased and became indurated, with enlargement of the overlying veins. Another roentgenogram, six days after admission, showed definite periosteal reaction. Sarcoma was considered a possible diagnosis but aspiration biopsy yielded only flecks of blood and amorphous material.

Two weeks after admission, because of the continuing process and because no definite diagnosis had been made, a surgical biopsy was performed. Beneath the deep fascia was gray-pink necrotic muscle tissue that was friable and could be dislodged in clumps with the fingers. The periosteum was greatly thickened and there was increased vascularity between the periosteum and the femoral shaft. The cortical portion of the femoral shaft was so porous that it resembled can-

cellous bone. After seeing the gross tissue and examining a frozen section, the pathologist made a diagnosis of sarcoma. Since radical treatment would have meant a very high thigh amputation, a detailed study of the histopathologic sections was made before proceeding with destructive surgery. Study of the paraffin sections led to a diagnosis of "pseudosarcoma stage of myositis ossificans." This diagnosis was confirmed by other specialists in bone pathology and was roentgenologically apparent one week after the operation. A cloud of well demarcated ossific material was seen in the muscle mass of the thigh surrounding the femoral shaft—the characteristic x-ray appearance of myositis ossificans. Several months later, the roentgenogram showed a definite mass of bone in the quadriceps muscle.

The authors feel that aspiration biopsy is worthless and that frozen section may be hazardous and deceiving, since osseous tissue cannot be made into good microscopic sections by this technic. Amputation for treatment of bone tumor should never be performed until permanent, good tissue sections have been examined by competent pathologists. It seems likely that some of the reported five-year cures of osteogenic sarcoma cases may actually represent a misdiagnosed pseudosarcoma stage of myositis ossificans.

Three roentgenograms. JOHN J. CRAVEN, M.D.
Cleveland Clinic

A New Variety of Generalized Familial Benign Osteosclerosis. Bruno Bonomini. *Radiol. med. (Milan)* 40: 273-287, March 1954. (In Italian)

In 16 of 31 persons examined, representing three generations of a single family from the province of Padua, the author encountered a generalized osteosclerosis. The ages of the affected persons ranged from several months to seventy-one years. This entity shows a simple dominant inheritance and a benign course. Clinically, the patients presented an increase in volume of the cranium, with a projecting forehead and an apparent depression of the eyes. The bones most extensively involved were those of the cranial vault, the base of the skull and the maxilla, the central portions of the vertebral bodies (with a spread of the sclerosis later to involve the whole body), the ribs, scapulae, and pelvis (as in the vertebral bodies, the sclerosis begins centrally and spreads peripherally), the clavicles, the diaphyseal regions of the metatarsals, metacarpals, and phalanges. Rarely foci of sclerosis are seen in the metaphyses, and even more rarely in the epiphyses.

The changes in the skull and those in the short bones are among the most characteristic and first to appear. The changes are static in adulthood but in senility there is a tendency to partial resorption.

There are no symptoms, no tendency to fractures, and no significant change in the blood picture except for a constant increase in calcium, which is not associated with changes in the phosphates.

In differential diagnosis the following conditions must be considered: (1) infective, neoplastic, or toxic osteopathy, such as lead and phosphorus poisoning; (2) endocrine disturbances involving the metabolism of calcium; (3) the hereditary osteoscleroses, which include (a) Albers Schönberg's disease, (b) Camurati-Engelmann's disease, and (c) spotty and striate osteopoikilosis.

Twenty-six roentgenograms; 1 genealogical chart.
CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Milkman's Disease (Osteomalacia). Report of a Case Which Shows that Milkman's Disease May be "Simple" Vitamin D Deficiency in Adults. Norman J. Winston and Eugene P. Pendergrass. *Am. J. Roentgenol.* 71: 484-489, March 1954.

Milkman's disease was first described by Milkman in 1930. Since then, Albright (see Medicine 25: 399, 1946) has reviewed the entire subject of osteomalacia and has suggested four clinical classifications:

1. Chemical osteomalacia with normal phosphates.
2. Chemical osteomalacia with high phosphates.
3. Milkman's syndrome.
4. Advanced osteomalacia.

The authors report the case of a woman of thirty-six with a twenty-one-year history of osteomalacia in different stages, with at least one period in which a classical Milkman's syndrome was present. This case is believed to demonstrate a transition from a Milkman's type of osteomalacia to the generalized type. The disease in this instance was believed to be due to simple vitamin D deficiency, though Albright had been able to find no cases attributable to this factor in the American literature.

Eleven roentgenograms. JOHN WATTS, M.D.
University of Louisville

Osteitis Condensans Ilii. David Robinson and W. U. Clary. *J.M.A. Georgia* 43: 130-133, February 1954.

Two cases are presented, each showing typical x-ray evidence of osteitis condensans ili. In the first case a lumbar myelogram showed blunting of the nerve sheath of S-1 on the right. Hemilaminectomy was done, and careful examination of the lumbosacral interspace failed to reveal a herniated disk. Following surgery, the patient continued to complain of intermittent low back pain with radiation into the right hip and episodes of pain initiated by lifting and straining. Prolonged standing and coughing aggravated the symptoms. There was radiation of the pain down the right leg in the posterolateral aspect. These symptoms and the physical findings are entirely compatible with the diagnosis of disk herniation. The authors feel that the failure to find a herniated disk surgically indicated that the symptoms may be produced by osteitis condensans ili.

The second patient had similar complaints but was not subjected to myelography or laminectomy. The conclusion was reached, however, that sclerosing lesions in the ilia might be responsible for the symptoms. Conservative treatment with bed rest and mild analgesics resulted in improvement.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Osteogenesis Imperfecta Congenita in Consecutive Siblings. Arthur A. Goldfarb and Douglas Ford. *J. Pediat.* 44: 264-268, March 1954.

Heredity aspects of the congenital type of osteogenesis imperfecta are usually not considered prominent, whereas in the infantile type and the late type the disease definitely follows a dominant mendelian trait. In these latter types, blue sclerae, frequent fractures, and deafness are seen in that order of frequency in the afflicted families as a definite hereditary factor which has been reported to follow through at least seven generations. The birth of two consecutive sib-

lings with the congenital type, however, is not characteristic and is unexpected. Two such cases are reported here, the second and third offspring of the same parents. The roentgen findings in the skull, the long bones, and the bodies of the vertebrae were those usually seen in osteogenesis imperfecta. Both infants followed the same clinical course, with death occurring after the onset of an intercurrent respiratory tract infection which failed to respond to antibiotics. The first sibling expired at five and a half months and the second at five months after birth. A first-born child was apparently normal physically and mentally.

One roentgenogram.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Vertebral Fractures as a Complication of Electroconvulsive Therapy. Paul A. Dewald, Norman M. Margolis, and Herbert Weiner. *J.A.M.A.* 154: 981-984, March 20, 1954.

Two hundred and sixty-three patients who received 285 courses of electroconvulsive therapy in a general hospital were studied by means of pre-shock and post-shock roentgenograms to discover the incidence of vertebral fracture. In 72 courses given to men and 213 given to women, the overall fracture incidence was 20.8 per cent. The rate in men was 42.9 per cent; in women, 13.7 per cent. Altogether 49 fractures occurred. In 54 patients in whom convulsive therapy was begun and maintained with decamethonium bromide the fracture incidence was only 1.9 per cent.

Most fractures occur during the first three treatments, and the vertebrae most often involved are the fifth, fourth, and sixth dorsal. Osteoporosis and the sex of the patient were significant factors in the incidence of fractures. Age, position of the patient, restraint, and method of initiating the current did not play a role. Muscle relaxants were shown to reduce the incidence of fractures significantly, and the authors believe that they are indicated in patients with osteoporosis and with large muscle mass.

Of the patients complaining of back pain, 75.6 per cent had fractures. Of the entire series of 49 fractures, 15 produced no symptoms and were discovered only on routine films. Any accurate evaluation of the incidence of these fractures following electroshock therapy must include films taken before and after treatment, since frequently the only evidence is minimal compression of the superior plates of the vertebrae. Unless a control film is available for comparison, these fractures may be overlooked entirely.

JOHN J. CRAVEN, M.D.
Cleveland Clinic

Retroperitoneal Approach to Lumbar Disc. Eugene B. Ley and W. D. Thurston. *Rocky Mountain M. J.* 51: 121-123, February 1954.

The authors enthusiastically recommend an anterior retroperitoneal approach to the lumbar disks in cases where myelography is negative or the protrusion is minimal. They have used this procedure in 25 cases.

They first expose the fourth and fifth interspaces anteriorly and then inject Diodrast for diskograms. After determining which disks are at fault, they proceed to evacuate the degenerated tissue, curette the bone surfaces, and insert iliac bone for grafting between the vertebral bodies. In some cases additional films are obtained after the degenerated nucleus has been re-

moved to determine whether the protruding portion of the degenerated disk has been successfully removed.

Advantages claimed are absence of operative shock and a better and more logical spinal fusion. The average time for the operation, including diskography, was one hour.

[This certainly seems to be a sensible approach to the disk problem, and easier for both patient and surgeon.—Z.F.E.]

Two roentgenograms. ZAC F. ENDRESS, M.D. Pontiac, Mich.

Roentgen Changes in Transient Synovitis of the Hip Joint. Mortimer B. Hermel and David M. Sklaroff. *Arch. Surg.* 68: 364-368, March 1954.

Two cases of transient synovitis of the hip are reported. The condition usually affects children less than ten years of age, and boys more frequently than girls. The presenting symptoms are a limp, limitation of all motions of the hip, and a low-grade fever. The diagnosis is established roentgenologically. The joint capsule is seen to be distended and swelling of the musculature is noted in the obturator internus, gluteus minimus, and iliopsoas. The condition is to be differentiated from osteomyelitis, tuberculosis, syphilis, Legg-Calvé-Perthes' disease, slipped capital femoral epiphysis, rheumatic fever, and rheumatoid arthritis. The etiology is unknown, but trauma, infection, and allergy have all been considered to play a part.

The disease is of short duration and self-limited. As a rule it subsides within three days. Rest of the involved lower extremity is frequently sufficient treatment. In severer cases traction may be necessary. Healing is complete, and no sequelae have been reported.

[The authors make no mention of a possible confusion of transient synovitis with septic arthritis of the hip, which is a much more serious malady. The latter is considered by E. B. D. Neuhauser to be a true pediatric emergency, requiring early diagnosis and immediate treatment if the hip joint is to be preserved.—A.S.T.]

Four roentgenograms. ARTHUR S. TUCKER, M.D. Cleveland Clinic

Osteogenic Sarcoma Complicating Paget's Disease of the Femur. Raphael R. Goldenberg. *J. M. Soc. New Jersey* 51: 106-108, March 1954.

A case is reported illustrating the rapidity with which an osteogenic sarcoma may develop in a pre-existent Paget's disease. In the original roentgenograms, taken because of an injury to the thigh, the fracture so dominated the picture that the presence of Paget's disease was not considered. Twelve weeks later roentgen examination showed extensive infiltration of the soft tissues by a dense sclerotic process, extending from the region of the ischial tuberosity distally to the level of the lower third of the left femur. The bone fragments presented areas of rarefaction and sclerosis. Biopsy was done, and the histologic diagnosis was "osteogenic sarcoma developing in Paget's disease." Evidence of Paget's disease was also present in the tibia and spine.

Two roentgenograms; 2 photomicrographs.

Fractures of the Ankle. III. Genetic Roentgenologic Diagnosis of Fractures of the Ankle. N. Laugesen. *Am. J. Roentgenol.* 71: 456-471, March 1954.

This is one of a series of papers on fractures of the ankle, of which 4 (I, II, IV, and V) have appeared else-

where (see *Absts. in Radiology* 52: 297, 1949; 56: 781, 1951; 60: 466, 1953; 63: 613, 1954).

In the present paper the author reviews the literature and comes to the conclusion that measurement of the syndesmotic space does not afford a safe criterion for the presence or absence of syndesmotic rupture and diastasis. He approaches the problem in an altogether different way, with experimental roentgenographic and surgical investigations. On the basis of his observations he has developed what he designates as the "genetic" roentgen diagnosis of ankle fractures ["genetic" here referring to the genesis of the fracture].

Four types of fractures are found which pathologically occur in constant and characteristic stages and are found to correspond to the clinical fractures of the ankle. These four types are described by a dual designation, which denotes the two main factors of each type of fracture, *viz.*, the position of the foot at the time of the injury and the forced movement of the foot producing the fracture. The type is characterized by the location and form of the fibular fracture, and the stages in each type are determined by the combination of the fibular fracture with the fractures involving the ankle region. We have, thus, supination-adduction, supination-eversion, pronation-adduction, and pronation-eversion fractures.

In all four types of fracture the first stage may be a ligamentous detachment, and for the demonstration of this, special roentgen examination may be required. If such an examination is omitted in the presence of clinical symptoms of a lesion of the ankle joint, approximately 30 per cent of serious lesions, namely, the "ligamentous" ankle fractures, will not be diagnosed primarily. Isolated lesions of the ankle ligaments are equivalent to ankle fractures with regard to genesis and tendency to dislocation, and the treatment should be as in the case of the latter.

Twenty-seven roentgenograms; 4 drawings; 1 table.

THOMAS E. PADGETT, M.D.
University of Louisville

GYNECOLOGY AND OBSTETRICS

Routine Antepartum Roentgen Pelvimetry in Primigravidas. A. Marck and A. Melamed. *Am. J. Obst. & Gynec.* 67: 564-567, March 1954.

This consideration of the value of routine antepartum roentgen pelvimetry in primigravidas is based on examinations in 300 patients. On the basis of roentgen pelvimetry, 54 of this number were placed in a "guarded" or "poor" prognosis group. Only 13 of these, however, required operative delivery. Seventeen of the "good" prognosis group required major forceps procedures to accomplish delivery. These observations would suggest that the routine screening of primigravidas by roentgen pelvimetry is not essential for the management of labor. Without integration with the clinical features, roentgen pelvimetry may prove misleading in the determination of obstetrical prognosis and choice of operative measures when such are indicated.

Three tables. THEODORE E. KEATS, M.D.
University of California, S. F.

The Diagnostic Value of Hysterosalpingography in Tubal Pregnancy. Kristina Ekengren and Åke B. V. Rydén. *Acta radiol.* 41: 247-255, March 1954.

Hysterosalpingography can materially aid in the

diagnosis of tubal pregnancy where the clinical course is atypical or even pick up entirely unsuspected cases.

The authors present 12 cases of their own examined with a water-soluble contrast medium and verified pathologically. Roentgen appearances were of two types. In one the ovum was surrounded, in the tube, by the contrast medium, and appeared as a filling defect. In the other the opaque medium penetrated into the intervillous spaces of the ovum. Examples of each type are illustrated by roentgenograms and sections of injected operative specimens.

The use of water-soluble contrast media is urged. No complications followed these studies.

Sixteen roentgenograms; 6 photomicrographs.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Ureterovaginal Fistula. Rexford G. Carter. *J. Urol.* 71: 200-207, February 1954.

This article deals with operative injury to the ureters, resulting in a ureterovaginal fistula. While there is general agreement as to the cause of the accident, a difference of opinion exists as to the best course to pursue once urinary leakage has occurred. Most gynecologists and surgeons feel that watchful waiting is justified. The majority of urologists, on the other hand, feel that prompt intervention is necessary to save the damaged kidney and ureter.

The injury is due almost exclusively to some form of hysterectomy. It occurs in about 0.4 per cent of all hysterectomies and is most frequently associated with the removal of large intraligamentous fibroids. It is usually caused by catching the terminal portion of the ureter in a suture or clamp. The injury produces some degree of obstruction, and infection may appear. As time goes on, the damage becomes progressively more severe. Within two or three months, the kidney will cease to function and the fistula will stop draining.

If the injury is recognized at the time of operation, an end-to-end anastomosis over a ureteral catheter is successful in a high percentage of cases. The procedure of tying the ureter and dropping it back into the abdomen is mentioned only to be condemned. Some doctors advise using ureteral catheters preoperatively.

The symptoms of ureteral injury usually appear within three to ten days following operation. In most cases the injury is unilateral; bilateral injury constitutes an emergency requiring immediate treatment. Once leakage of urine begins, it finds its way to the outside by the easiest means—usually through the suture line in the vagina.

The most valuable procedure in diagnosis is intravenous urography. The injured side may show delay in concentration of the medium and dilatation of the ureter and renal pelvis. If the damage has existed for a long time, function may be completely lacking. Cystoscopy should then be performed to rule out bladder injury. An attempt to pass a catheter up the injured ureter is usually unsuccessful. Dye can be given to estimate the function of both kidneys. On the injured side this will not be excreted into the bladder, but if function is present, the dye can be detected by a sponge placed in the vagina.

The time element in treatment is extremely important. If the damaged kidney is beyond salvage or the injury too high in the ureter to permit repair, nephrectomy is indicated. If the injury is within the lower 10 cm. of the ureter, some type of transplantation proce-

dure is usually possible. If the proximal ureter is too short to transplant into the bladder, it can be transplanted to the opposite ureter or large bowel, but this is usually not done if the opposite kidney is normal.

The author presents 4 cases, 2 in which a nephrectomy was done and 2 in which repair was successfully performed. In most of the series reported to date, the renal mortality rate is about 50 per cent.

Six roentgenograms. JAMES A. LYON, JR., M.D.
University of Pennsylvania

THE GENITOURINARY SYSTEM

A Method of Roentgenography of the Male Genital Tract. Arthur S. Tucker, Hanabusa Yanagihara, and Arthur W. Pryde. *Am. J. Roentgenol.* 71: 490-500, March 1954.

The authors obtained roentgenograms of the vasa deferentia in 18 Japanese volunteers, injecting either Umbrathor or Thorotrast, both of which are colloidal preparations of thorium dioxide. Umbrathor flocculates and coats the surface of the vas deferens. However, the precipitate is unevenly distributed and there is danger of thrombosis if any of the medium enters a vessel. Thorotrast is a suspension of fine particles of neutral reaction and is safe for intravascular injection, without danger of local irritation. Unfortunately, should it enter the blood stream, it will provide prolonged exposure due to the alpha particles it emits. Thorotrast lacks the contrast of Umbrathor but provides a more continuous outline of the lumen.

Only one immediate reaction to the injection—chills and fever lasting five hours—occurred in the series of 18 cases. Follow-up studies as to possible fibrosis with subsequent complete occlusion of the vasa deferentia have not been made to date. In only 2 of the 18 cases was there failure to visualize the vasa deferentia.

Case reports for all 18 patients are given, with 15 roentgenograms made at varying intervals following the injections. JOHN F. BERRY, M.D.
University of Louisville

Interrelationship of Renal Cysts and Tumors; Report of Three Cases. Thomas E. Gibson. *J. Urol.* 71: 241-252, March 1954.

Three cases of coexistent renal cysts and tumors of various types are presented in an effort to illustrate their interrelationship. The author suggests 4 possibilities in explanation of the coexistence of cysts and tumors: (1) unrelated origin of cyst and tumor; (2) origin of a cyst within a tumor; (3) origin of a tumor within a cyst; (4) origin of a cyst distal to a tumor. He cites experimental studies supporting the view that renal cysts may be produced by combined ureteral or tubular obstruction and vascular occlusion such as is produced by a tumor. These cysts arise peripheral or distal to the tumor site but may eventually engulf the growth. This would appear to be the explanation of one of the cases reported here.

The incidence of malignant tumor in cases of cystic disease has been given as 7 per cent, a figure which is increased to 30 per cent in hemorrhagic cysts.

The author concludes that cystic disease of the kidney should be explored with the idea of a malignant neoplasm in mind.

Nine illustrations, including 4 roentgenograms.

HAROLD L. ATKINS, M.D.
University of Pennsylvania

Solitary Cysts of the Kidney: Report of a Case in an Infant. E. H. Travers. *J. Urol.* 71: 253-255, March 1954.

A review of the recent literature indicates that the majority of solitary renal cysts are diagnosed in the fifth decade of life. The youngest patient previously reported was aged one year. The author's patient was operated on at the age of four weeks. The occurrence of a solitary renal cyst at this early age is held to support the theory that the condition is of congenital rather than of acquired origin.

The child was brought to the hospital because of a large rounded mass filling the entire right side of the abdomen. At operation a cystic retroperitoneal tumor was identified as representing the right kidney and was removed. The lining of the cyst was of delicate fibrous tissue devoid of epithelium. The renal tissue was compressed, with glomeruli in the parts adjacent to the cyst. Approximately 20 ounces of clear, colorless fluid was evacuated from the cyst at operation. The infant made an excellent recovery. The preoperative roentgenogram is reproduced, showing an opacity filling the entire right side and the left upper quadrant of the abdomen.

HENRY P. PENDERGRASS, M.D.
University of Pennsylvania

Emphysematous Cystitis. Erik Boijesen and Johannes Lewis-Jonsson. *Acta radiol.* 41: 269-276, March 1954.

The writers present what they believe to be the third case of emphysematous cystitis ever to be diagnosed primarily by roentgenography. [For the cases referred to by the authors, see Lund, Zingale and O'Dowd: *J. Urol.* 42: 684, 1939; Teasley: *J. Urol.* 62: 48, 1949. Abst. in *Radiology* 54: 918, 1950. They do not mention Milner *et al.* (New England J. Med. 246: 902, 1952. Abst. in *Radiology* 60: 624, 1953), who reported what they believed to be the sixth case. Four original cases were also reported by Faingold, Hansen, and Rigler (*Radiology* 61: 346, 1953).—Ed.]

The patient was a diabetic with a recurrent urinary tract infection. Bacteriologic examination of the urine revealed coliform rods, *Proteus vulgaris*, and enterococci. On urography the bladder mucosa appeared swollen, and the thickened wall showed a large number of roundish defects with a density indicative of a gaseous content. On this basis the diagnosis was made.

The most common cause of emphysematous cystitis is infection by bacteria of the colon group, which ferment glucose with the formation of gas. In diabetes the glucose in the bladder wall is considerably higher than normal, which accounts for the increased incidence of emphysematous cystitis in diabetics. The gas is localized in the tissue spaces of the mucous membrane and, when the vesicles break, may be seen rising toward the dome of the bladder during cystoscopy. Passage of gas on urination is not pathognomonic of emphysematous cystitis but is highly suggestive.

The roentgen picture changes with the progress of the disease. First, the gas is seen as a clear zone about 1.0 mm. wide around the contrast medium in the bladder; secondly, as gas production increases, this zone enlarges and becomes more irregular and thicker; subsequently the gaseous vesicles rupture and there is gas in the bladder, with only a small amount remaining in the wall. Both horizontal and vertical views will help to differentiate this condition from pneumaturia, in

which the free gas collects in the dome of the bladder rather than around the contrast medium.

Treatment is by antibiotics and control of the general condition, with particular reference to the diabetes.

Four roentgenograms. JOHN F. BERRY, M.D.
University of Louisville

Follow-up Studies of Bladder Extrophy with Ureterosigmoidostomy. Robert A. Garrett and John H. O. Mertz. *J. Urol.* 71: 299-306, March 1954.

The incidence of extrophy of the bladder is said to be about 1 in 30,000 to 40,000 births. The authors review their experience in 12 cases in which the ureters were transplanted into the large bowel. Several surgical techniques were used, but the ureters were placed as low in the bowel as possible. The postoperative complications were few, consisting of obstruction at the site of anastomosis with hydronephrosis, leakage around the anastomosis, and pyelonephritis in 6 patients.

The authors analyze their findings on the basis of the 24 ureteropelvic systems involved rather than the 12 individual patients. Prior to the transplantation, 19 ureteropelvic systems were found to be normal, 2 showed pyelonephrosis, and 1 advanced hydronephrosis. In 1 case no preoperative pyelographic study was obtained. Pyelograms of 17 of the 23 transplanted systems (74 per cent) were considered normal at the latest follow-up; 6 (26 per cent) showed some dilatation or erosion not present prior to surgery. Ureterograms, on the other hand, were normal in 12 (52 per cent), while 8 (35 per cent) showed some dilatation and 3 (13 per cent) did not afford sufficient visualization to warrant an opinion.

Because of the work of Baker and Miller (*J. Urol.* 67: 638, 1952), showing that a reflux of bowel contents into the transplanted ureter was common, the authors made a Skiodan enema examination in their patients with sufficient pressure to produce a strong urge to defecate. On subsequent films, only one ureter was found to show reflux.

Electrolyte profile studies were obtained in all patients. These included determinations of serum sodium, potassium, chloride, and CO₂-combining power. At one time or another, all cases showed chloride levels in excess of normal. Eight of the 11 patients studied showed a reduction of alkaline reserve as indicated by subnormal levels of the CO₂-combining power, while 9 displayed subnormal levels of serum potassium.

Three features are pointed out as contributing to a poor result in ureterosigmoidostomy, namely, obstruction, infection, and electrolyte imbalance. Infection tends to be mild unless obstruction is also present; electrolyte imbalance regularly occurs in the clinical absence of the other two, but is more severe when they are present.

Urography early in the postoperative period often discloses a temporary pyelectasis and ureterectasis which is probably due to edema at the operative site. Pyelography at three-month intervals is most reliable in evaluating the anastomosis.

It is thought that in severe cases of acidosis, which is brought about by the resorption of chloride in the rectal mucosa, renal parenchymal damage will result. The importance of understanding electrolyte changes is apparent.

Six roentgenograms; 3 tables.
A. E. O'HARA, M.D.
University of Pennsylvania

Congenital Valves in the Posterior Urethra. D. Innes Williams. *Brit. M. J.* 1: 623-627, March 13, 1954.

Of congenital anomalies causing urethral obstruction, the most often encountered is a valvular formation of mucosal folds. The author's observations are based on 14 cases of congenital valves for which he personally operated and on 21 cases from the autopsy records of the Hospital for Sick Children in London. He discusses the clinical features, diagnosis, management, and results of treatment.

The most important radiological contribution to the diagnosis of this condition is the "micturating cystogram." A catheter is passed and residual urine is drawn off and replaced by a rather larger volume of a 15 per cent solution of Diodone. The catheter is then withdrawn and exposures are made during micturition. Radiologically there may be trabeculation of the bladder, diverticula, reflux into dilated ureters, or dilatation and elongation of the posterior urethra. The cystourethrogram shows the exact site of obstruction, and occasionally the outline of the valvular folds can be demonstrated.

Three roentgenograms; 1 photograph; 1 drawing.

ROBERT H. LEAMING, M.D.
Memorial Center, New York

MISCELLANEOUS

Clinical and Radiological Observations on 102 Cases of Sickle-Cell Anemia. G. Tori. *Radiol. clin.* 23: 87-108, March 1954. (In English)

The author reviews the clinical and radiologic aspects of 102 cases of sickle-cell anemia seen during the last three years at the Charity Hospital of New Orleans. His radiologic findings may be summarized as follows:

1. Forty per cent of the cases showed enlargement of the heart, either general or right ventricular. The former was explained by the chronic anoxia and the latter by the circulatory stasis produced by thrombosis of the small arteries of the lungs. The frequent pulmonary manifestations were probably the result of vascular thrombotic processes.

2. In children, the long bones showed a coarsening of the trabecular pattern, with widening of the interposed spaces, probably due to increased hematopoiesis. Later in life, the medullary cavity may become narrowed due to production of new bone. Several cases presented a pattern suggestive of bone infarcts.

3. The flat bones of the skull were often osteoporotic. Only 2 of the 102 cases presented the so-called "hair-on-end" picture. This occurs in other diseases, such as erythroblastotic anemia and hemolytic icterus, and is probably related to increased hematopoiesis. Other flat bones, as the ilia, ribs, and scapulae, may be osteoporotic.

4. The short bones of the extremities and the vertebral bodies also may show osteoporosis. In the latter case, a "fish-tail vertebra" appearance may result, due to the pressure of the nucleus pulposus upon the weakened vertebral bodies.

While the radiologic findings in sickle-cell anemia are not pathognomonic, they can lead the clinician to the correct diagnosis when regarded *in toto*, especially in those cases with a wide range of clinical manifestations.

Twenty-one roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
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Thalassemia in Two Egyptian Families. H. Shukry and S. Awwad. *Arch. Pediat.* 71: 67-76, March 1954.

Three cases of thalassemia major (Cooley's anemia) in children in two Egyptian families are reported. The parents in both families and some of the brothers and sisters of the children showed evidence of thalassemia minor. Roentgen studies in all 3 cases revealed bony changes but these did not run parallel with the severity of the disease as judged by the clinical and hematologic picture. No benefit was derived from any form of treatment, including cobalt therapy, vitamins, liver extract, and blood transfusions.

Four roentgenograms; 3 photomicrographs; 1 photograph.

Letterer-Siwe's Disease. Problems in Diagnosis and Treatment. Eugene L. Saenger and Ralph J. Johansmann. *Am. J. Roentgenol.* 71: 472-482, March 1954.

Letterer-Siwe's disease (non-lipoid reticuloendotheliosis) is a rare, usually fatal disease, occurring most frequently in children under two years of age and characterized clinically by hemorrhagic rash, hepatomegaly, splenomegaly, lymphadenopathy, and anemia. The authors present 4 cases observed at the Children's Hospital in Cincinnati, with emphasis on the roentgen findings.

The first case was that of an eight-day-old child with a generalized crusted rash which became pustular. The patient was irritable and had a temperature of 102°. The superficial lymph nodes were enlarged, but the liver and spleen were not palpable until later in the course. Roentgenograms of the chest revealed a finely nodular infiltrate scattered throughout both lung fields. The child died thirty-seven days after admission. A skin biopsy was performed and a diagnosis of Letterer-Siwe's disease was made. The second case showed a similar severe, fulminating course.

In the third case the onset was early, but symptoms developed more gradually. The onset in the fourth patient was later, at about one year, and the child was alive after some four years. A fifth case, observed only for a short period and terminating in death, is included because of certain atypical features. It developed in association with a typical Hand-Schüller-Christian syndrome.

In 4 of the 5 cases, finely nodular densities measuring 1 to 3 mm. were scattered throughout both lung fields. If the child survived any length of time, there was an associated emphysema. The lesions appeared similar to those seen in cystic fibrosis of the pancreas, acute histoplasmosis, and disseminated tuberculosis. Only the association with skin lesions suggested the proper diagnosis.

Roentgenograms of the long bones showed progressive thinning of the cortex and widening of the medulla. In 2 of the cases osteolytic lesions with well circumscribed borders, such as are usually seen in Hand-Schüller-Christian syndrome or eosinophilic granuloma, were present. The liver and spleen were enlarged in all the patients.

Though the course is usually fatal, in several of the cases life appeared to be prolonged by antibiotics and radiation therapy. While the lesions are frequently radiosensitive, they subsequently recur.

Eight roentgenograms; 1 photograph; 3 photomicrographs.

LAWRENCE A. DAVIS, M.D.
University of Louisville

Inclusion Disease of Infancy. Case Report. H. Stephen Gallagher, Joseph W. Stayman, Jr., and Philip S. Barba. *J. Thoracic Surg.* 27: 222-226, March 1954.

The authors report a case of cytomegalic inclusion disease, known also as generalized salivary gland virus infection. This disease is characterized by intranuclear and intracytoplasmic inclusion bodies in enlarged cells of many organs. All of the previously described cases of this disease have been found at autopsy. The case reported here was discovered during life and the patient made a clinical recovery.

Jaundice, splenomegaly, and slight enlargement of the liver were observed on the sixth day of life, followed by cyanosis, dyspnea, and a loose cough, productive of blood-tinged sputum. Chest films revealed an opacity of the right upper lung field which soon involved the entire right lung. This was considered to represent either atelectasis, consolidation, or both. Three weeks after the onset of the disease areas of radiolucency appeared in the right lung, progressing in size until four large air-filled cysts filled the right side of the chest and displaced the mediastinum toward the left.

Because of the progressive enlargement of the cyst and persistent symptoms, a thoracotomy was performed. The group of cysts were found to arise from the apex of the lower lobe and the base of the upper lobe on the right. The uninvoluted lung was compressed against the mediastinum. After resection of the involved segments, the cyanosis disappeared and the patient remained well.

Scattered through the sections of excised lung tissue were large cells containing intranuclear and intracytoplasmic inclusion bodies. The cells were apparently derived from bronchiolar lining cells. In one section, a nodule of large inclusion-bearing cells was seen to project into the lumen of a small bronchus. This may have been either obstructive or productive of a ball-valve effect.

The authors feel that there may be many cases of this disease with recovery that go undiagnosed. Whether cystic changes in the lungs or other organs may be sequelae of inclusion disease can be determined only after study of more healed cases.

Two roentgenograms; 3 photomicrographs.

R. G. FORTIER, M.D.
St. Paul, Minn.

Retroperitoneal Teratoma. J. Baštecký, J. Holý and R. Poch. *Acta Radiol. et Cancerol. Bohemoslov.* 7: 332-337, November 1953. (In Czechoslovakian)

A case of large retroperitoneal teratoma, incidentally discovered during x-ray examination of a twenty-three-year-old female, is presented in detail. The surgically removed tumor weighed 1,600 gm. The pathologic examination revealed structures of normal adult thyroid tissue, parathyroid, sympathetic ganglion, nerve fibers and blood vessels. The final histologic diagnosis was "teratoma coactaneum."

Four roentgenograms; 1 photograph.

E. A. SCHMIDT, M.D.
Denver, Colo.

TECHNIC

Enlargement Radiography Without Special Apparatus Other than a Very Fine Focal Spot Tube. Ernest H.

Wood and Charles A. Bream. *North Carolina M. J.* 15: 69-75, February 1954.

The maximum useful magnification of anatomic structures with the 0.3-mm. focal spot radiographic tube has been shown to be three to four times the normal size (Garnes: *X-ray Technician* 23: 323, 1952). Slightly greater than double magnification can be produced when such a radiographic tube is placed 24 inches above the top of a radiographic table and the cassette an equal distance beneath the table. Scattered radiation is eliminated by use of a radiographic cone, and the Potter-Bucky diaphragm with the tray removed.

This type of radiography requires a slight increase in exposure time over that used in conventional radiography. A table of technical factors is included in the report.

The method lends itself satisfactorily to enlargement stereoscopy. It is of value in examining bones and joints, soft-tissue calcifications, and the respiratory system. The increased detail available to the radiologist by means of enlargement radiography is most useful where detailed morphologic analysis is required in a lesion known to exist.

Eight roentgenograms; 2 photographs; 1 diagram; 1 table.

RICHARD F. MCCLURE, M.D.
Redondo Beach, Calif.

Automatic Kilovoltage Control in Spot Filming. Louis R. Harnick and H. McLean. *J. Canad. A. Radiologists* 5: 11-12, March 1954.

Dissatisfaction with the variability of phototimed spot films and with manual methods of making kilovoltage changes led the authors to devise an ingenious mechanism for obtaining spot films of uniform quality. This device automatically changes the kilovoltage setting in accordance with the thickness of the part being examined, leaving the time and milliamperage factors constant.

The in and out travel of the fluoroscopic screen (which must vary with the part thickness) is used to activate an electric circuit (not described in detail) consisting of two variac transformers and a reversible motor. Through connections with the autotransformer, a dual range of 70 to 100 kv and 50 to 80 kv is provided, both at whatever time is set previously. Two hundred milliamperes are used throughout.

The authors report satisfactory use of the method in 400 patients. At the time of the report, it had been used only in spot filming of the gastrointestinal tract and the bronchial tree.

[Such a device would seem to have definite advantages over phototiming in cost and servicing, as well as improvement in the quality of films.—Z.F.E.]

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Retroperitoneal Radiography with Oxygen Injection. Sam Downing, Tom Kennedy, and J. Philip Clarke. *Rocky Mountain M. J.* 51: 181-184, March 1954.

Six cases are presented to demonstrate the value of pneumoretroperitoneum. The technic employed is essentially the same as that used by Steinbach *et al.* (California Med. 75: 202, 1951. Abst. in Radiology 59: 619, 1952. See also Radiology 59: 165, 1952).

Eight roentgenograms; 1 drawing.

RADIOTHERAPY

Observations on Rotational Therapy with Two Million Volt Roentgen Rays. Hugh F. Hare, Magnus I. Smedal, David Johnston, Maurice Cote, John G. Trump, Kenneth A. Wright, Richard Granke, and René A. Beique. *J.A.M.A.* 154: 890-894, March 13, 1954.

The authors have treated about 500 patients with advanced malignant disease in forty-four different locations throughout the body, with two-million-volt x-rays, using rotational or multiportal methods. The source was an electrostatic accelerator of the Van de Graaff type. Although the radiation quality of this source is assumed to be roughly equivalent to that of gamma rays from radium and Co^{60} , the authors claim two clinical advantages for this machine accelerator: (1) a high x-ray output, greater than the gamma roentgen output of 6,000 gm. of radium or of 4,000 curies of Co^{60} , and (2) an almost "point" source of radiation, permitting sharp beam definition, with avoidance of the large penumbra characterizing radioactive sources of even moderate output. Because of greater penetration and less scatter, the skin reaction and systemic discomfort were less at high tumor doses than with conventional deep x-ray therapy.

Radiographs of the actual treatment field taken at 2 Mev proved valuable in insuring accurate positioning or for observing changes in the tumor in some instances. These films provided tangible evidence of the lower absorption of bone for supervoltage radiation, substantiating in a sense the impression that the tolerance of bone for two million volt x-rays is significantly greater than for conventional irradiation.

Rotational treatment was found advantageous for many localized tumors, and cross-sectional isodose curves obtained with this method for two representative situations in the head and pelvis are presented.

A brief discussion of the treatment program used with respect to dose levels and of time-dose relationships for neoplasms of various types is given.

No attempt to judge curability could be made, inasmuch as the maximum period of observation was three and a half years, the disease was advanced and hopeless in many instances, and a large percentage of the patients had received previous surgery or irradiation.

Six figures, including 1 roentgenogram.

DELBERT E. BOBLITT, M.D.
University of Michigan

The Treatment of Glioblastomas with Radium. Ernest Sachs. *J. Neurosurg.* 11: 119-121, March 1954.

In a group of 789 gliomas seen between 1911 and 1946, the author encountered 261 glioblastomas. Of the latter group, he was able to review adequately the history and course in 154: 4 patients survived three years, 8 for two years, and 2 over one year.

Particular study of the cases with longer survival failed to indicate any variation in histopathology or location to explain the survival. The duration did seem, however, to be correlated with the amount of radiation, those patients living longest having received the highest doses.

Because of the technical difficulty in giving a large localized dose of roentgen radiation to the postoperative tumor site, the author used implanted gold radon seeds at the time of surgery. The seeds were of 1 me strength

and were placed in a plane at 1 cm. intervals, up to 40 seeds being used for a total dose of about 11,000 r. The high local dose, the ease of application, and the difficulty involved in giving a similar dose of external irradiation are felt to be strong points in favor of this type of treatment.

E. E. TENNANT, M.D.
Denver, Colo.

Inoperable Carcinoma of Antrum of Highmore. Report of a Twenty-Year Survival After Telecurietherapy and of a Five-Year Survival After Roentgen-Grid Therapy. Hirsch Marks. *Arch. Otolaryng.* 59: 340-346, March 1954.

The author presents 2 cases of carcinoma of the antrum. One patient, a 65-year-old woman, had nasal polyps persistently recurring after excision over a period of ten years. At the end of that time, tissue removed during a Caldwell-Luc operation revealed an epidermoid carcinoma with invasion of bone. A roentgenogram of the left antrum showed extension of the malignant process to the right naris, orbit, and lesser wing of the sphenoid. Treatment consisted of protracted x-ray therapy through a grid in an overall period of eight months. Four courses were given, consisting of 10 treatments lasting from fourteen to eight days each, with respites from treatment of thirty-six to forty days, dictated by clinical considerations. Radiation factors were: 0.9 mm. Cu h.v.l., 5 cm. target-skin distance, grid portals 5 X 5 cm., optimum single dose 1,200 r in air, with cross-firing through an anterior, right lateral, and left nasal port. Average tumor dose was 9,200 r at 5 cm. At the time of the report the patient had survived five years without recurrence.

The second patient, a 29-year-old woman, had a small growth in the region of the upper left gum, which had been diagnosed on biopsy as a spindle-cell sarcoma and treated by several light courses of x-ray therapy without effect. Roentgen examination showed destruction of the walls of the sinuses, especially of the floor of the left antrum. Treatment consisted in the application of radon capsules filtered by 4 mm. of lead, imbedded in a wax mold in circular fashion on the confines of the palpable and visible tumor, at a distance of 8 cm. from the skin surface. The mold was left in place for five days, except for daily cleaning, the total dose being 19,600 mc. hr. Five days after removal of the mold, there was a marked improvement in the local and general condition of the patient. Examination twenty years after irradiation revealed no evidence of recurrence of the tumor.

Two roentgenograms; 4 photographs; 1 photomicrograph.

Results of Roentgen Therapy in Cancer of the Larynx. Simeon T. Cantril and Franz Buschke. *Arch. Otolaryng.* 59: 326-329, March 1954.

This article is concerned only with the results of roentgen therapy in cancer of the larynx and does not include a description of the authors' technic of irradiation or any discussion of early or late complications. However, it permits certain conclusions regarding the role of irradiation and the place of surgery in laryngeal cancer.

During the period from 1938 to 1950, the authors examined 56 patients with epidermoid carcinoma of the larynx. This series includes cancers of the laryngeal

vestibule (epiglottis and false cords) but not cancers of the aryteno-epiglottic folds or piriform fossae. Included also are cancers of the endolarynx (true cords, ventricular cavity, and subglottic region). In the latter group, and in more advanced cases, it may be uncertain where the cancer has arisen, and the anatomic extent of the disease must be delineated as completely as possible, with the utilization of direct and indirect laryngoscopy and soft-tissue roentgenography. Eleven of the 56 patients were not treated. In 3, laryngectomy alone was advised. Forty-two received roentgen therapy; of this number, 16 are well three to fourteen years and 3 are well two years after irradiation. Five patients were treated by laryngectomy after failure of roentgen therapy, and 2 of these were well two to four years postoperatively.

The authors believe that their results indicate the following:

1. Cancer of the true cord which is limited to the vocal cord and has not encroached upon the anterior or posterior commissure, with free arytenoid mobility, can be controlled by roentgen therapy with an assurance equal to that of laryngofissure and cordectomy.

2. Of those patients who would otherwise have required a laryngectomy because of the extent of the disease only, roentgen therapy alone or followed by laryngectomy, when unsuccessful, salvaged 50 per cent. Of 25 patients in this group, 9 survived without a laryngectomy and with little impairment of voice. Failures included those who refused laryngectomy (2 cases), patients with severe cardiac conditions who would not have tolerated laryngectomy (2 cases), patients who died of metastases with the laryngeal cancer controlled (2 cases), and those who died of intercurrent disease with the laryngeal cancer controlled (4 cases).

Cases with necrosis of cartilage, arytenoid fixation, or subglottic cancer invading adjacent cartilage require initial laryngectomy. In some cases, x-ray therapy should be the initial treatment, with the understanding that laryngectomy may be necessary in the event of failure.

In all endolaryngeal cancer (other than early vocal cord lesions), laryngectomy alone offers a more certain prognosis, but with a high price in disability. The authors believe that operation is unnecessary in at least one-third of the patients in whom it is done.

3. Laryngeal cancers which have extended outside the larynx to invade the pharynx, base of the tongue, or adjacent structures of the neck are not necessarily hopeless. Twelve patients in the authors' series were considered inoperable. Six of this number have survived for more than four years after roentgen therapy, indicating that irradiation has more than a palliative role in laryngeal cancer.

Hemangio-Endotheli-Sarcoma of Bone, with a Case Report. Andrew R. McGee, Stuart F. Penny, and John B. Chetwynd. *J. Canad. A. Radiologists* 5: 13-16, March 1954.

Primary malignant vascular neoplasms of bone are uncommon, only about 25 cases having been reported. At one end of the angiomatic scale there is the well differentiated, highly developed blood vessel type, the slow-growing benign angioma. At the other extreme is the rapidly growing, poorly differentiated, cellular angioblastic lesion, the angiosarcoma, having cells of divergent morphology, with mitoses, metastases, and invasion of adjacent tissues.

The authors' patient was examined because of low-back pain and was found to have an extensive area of destruction in the left iliac bone. Biopsy led to a diagnosis of angiosarcoma. Since the lesion was considered inoperable, a tumor dose of 2,157 r (250 kv., No. 3 Thoraeus filter, h.v.l. 3.0 mm. Cu) was given in fourteen days and repeated in three months. Local recalcification occurred, but five months after the first lesion was discovered, similar radiographic changes were seen in the right ilium. Two courses of x-ray therapy (2,520 r in August and 1,440 r in the following February) again gave complete relief. In the meantime, in January, an additional 1,005 r were given to the left ilium.

Eighteen months later a metastasis appeared in the sternum and was destroyed with a tumor dose of 2,300 r. In September 1953 (three and one-half years from the original diagnosis), pain and suspicious x-ray findings in the right ilium led to administration of an additional 1,070 r. Four months later the patient had no complaints.

[While this patient cannot be considered cured by any means, it is certainly shown that irradiation can effectively control individual lesions of the type described.—Z.F.E.]

Five roentgenograms; 1 photomicrograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pregnancy in Hodgkin's Disease. Sven Hultberg. *Acta radiol.* 41: 277-289, March 1954.

The author reports a series of 373 cases of Hodgkin's disease treated at the Radiumhemmet (Stockholm) between 1921 and 1953; 167 of the patients were females, of whom 100 were between the ages of fifteen and forty-five years. Thirteen of these had one or more pregnancies and gave birth to 19 healthy children during the course of the disease. Brief accounts of these 13 cases are included. Eight patients were in good health eight to fifteen years after onset of their disease.

There were no exacerbations of the disease due to pregnancy, nor was there any evidence that it was transmitted to the child. Since pregnancy runs a normal course in these patients, the author does not consider its interruption indicated except under such circumstances as the following: (1) when there is a complicating tuberculosis or other disease; (2) where the general condition of the mother is such that death may be expected before term and it is impossible to save the child; (3) where the disease is localized in the pelvic area, making x-ray therapy impossible; (4) where nitrogen mustard or some other radiomimetic substance has been used.

The author emphasizes the importance of adequate roentgen therapy. He thinks it is necessary to give a total tumor dose of at least 2,000 r to prevent local recurrence. He uses 165 to 180 kv., 0.5 mm. Cu and 1.0 mm. Al filtration, 40 to 60 cm. focal-skin distance.

Nitrogen mustard should never be given during pregnancy, and patients having received such treatment should be advised against becoming pregnant.

JOHN WATTS, M.D.
University of Louisville

The Treatment of Plastic Induration of the Penis (Peyronie's Disease). Olov Dahl. *Acta radiol.* 41: 290-301, March 1954.

Peyronie's disease is a condition in which there is

fibrous induration of the intercavernous septum and/or of the tunica albuginea of the penis. This paper concerns the non-surgical management of the disease, with vitamin E therapy and irradiation.

Both natural vitamin E and synthetic preparations were used, 300 mg. being given by mouth daily for an average of nine months. Evaluation of results was based upon the effect on penile curvature, pain on erection, disturbances of coitus, and the character of the penile plaques which characterize the condition. Of 18 patients treated by vitamin E, 4 showed marked improvement, 6 moderate improvement, and 8 poor results.

A much larger series has received radiation therapy. The superficial circumscribed lesions are treated by 8-mg. radium tubes enclosed in glass capsules, fixed parallel to each other in one or two rows (see Strandqvist: *Acta radiol.* 20: 1, 185, 1939. *Abst. in Radiology* 34: 129, 1940). The deep and extensive lesions are treated by roentgen rays. The "average" dose with radium, *i.e.*, the average of that for the surface to a depth of 1.0 cm., is usually 1,100 r. With roentgen rays the usual skin dose is 1,200 r for one portal or 750 r through each of two opposing portals, fractionated over a period of three days. Of 96 patients treated with radium or roentgen rays, or both, 19 showed marked improvement, 34 moderate improvement, and 48 poor results.

The present series offers some evidence that vitamin E may bring about further improvement in previously irradiated cases, and *vice versa*. In view of this, a combination of the two methods would seem to offer advantages.

Two illustrations; 1 diagram.

JOHN WATTS, M.D.
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Deep X-Ray Therapy in Spondylitis. J. Sharp and E. C. Easson. *Brit. M. J.* 1: 619-623, March 13, 1954.

The authors report their results in a series of 332 cases of ankylosing spondylitis, 275 of which had received x-ray therapy since 1947 at the Christie Hospital and Holt Radium Institute, Manchester, England. The x-rays were generated at 250 kv., with a h.v.l. of 1.63 mm. of copper, the skin-target distance being 50 cm. Treatment has been given to the entire spine and sacroiliac joints even when the symptoms were confined to one level of the back. Most of the patients were treated as out-patients, a dose of 150 r (measured with back-scatter) being given to each field at weekly intervals for a series of ten treatments.

Clinicians are generally agreed that x-ray therapy is of some value but does not completely arrest the ankylosis process. It is believed that the beneficial effect is due to a local action on the irradiated tissues and not to an indirect effect mediated through an endocrine or other mechanism, and that failure of rheumatoid joints to improve is due to a difference in tissue response to x-rays.

The authors divide their 332 cases of spondylitis into three groups: 242 "typical," 59 "atypical," and an intermediate group of 31 "borderline cases." Of the 275 patients who received deep x-ray treatment, the proportion much improved was significantly higher in the "typical" group, as might be expected. Better results were obtained in patients with symptoms of not more than five years duration and in whom radiological changes were confined to the sacroiliac joints.

Complications of x-ray therapy included 1 case of

aplastic anemia, reactivation of pulmonary tuberculosis, permanent amenorrhea in 13 of the 47 females treated, and possible acceleration of renal failure in 2 cases.

The best long-term results are achieved by combining x-ray therapy with systematic exercises, positioning in bed and at work, and other physical measures designed to retain mobility and prevent or correct deformity.

Five cases are reported.

Six photographs; 2 tables.

ROBERT H. LEAMING, M.D.
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Distribution of Skin Doses over Scalp in Therapy of Tinea Capitis with Superficial X-Rays. John S. Strauss and Albert M. Kligman. *Arch. Dermat. & Syph.* 69: 331-341, March 1954.

The Adamson-Kienböck method of administering radiation for the treatment of tinea capitis has achieved widespread use in America. The x-rays are delivered over five unshielded focal points which are approximately 5 inches (13 cm.) apart. The authors have plotted the radiation delivered to various portions of the scalp with this technic. On either side of the occipital mid-line a small area of overlap was observed which received in "tissue roentgens" over twice the air dose given to the focal points. Most of the scalp receives doses which are one and one-half times (or more) as large as the air dose administered to a focal point.

The radiation is distributed with greater uniformity when the target-skin distance (TSD) is 25 rather than 20 cm. The radiation delivered to a single point falls off less rapidly at the periphery with the greater distance.

Preliminary studies indicate that the minimal, or threshold, dose for temporary epilation exceeds 300 r in air. The authors' data support the belief, validated by clinical experience, that the Adamson-Kienböck technic is quite safe for the routine epilation of fungus-infected scalps, provided the radiation is administered by experienced personnel with well calibrated equipment.

Five figures; 1 table.

Recent Observations on the Use of Nasopharyngeal Irradiation for the Control of Hearing Impairment in Children. John E. Bordley. *South. M. J.* 47: 246-249, March 1954.

A five-year study of hearing loss in 5,000 Baltimore, Md., school children, begun in 1948, has recently been completed. One of the objectives of the investigation was to explore the possibility of the use of nasopharyngeal irradiation for the reduction of adenoid masses and to determine the effect of such irradiation on impaired hearing of the conductive type. The 5,000 children, all in the third grade, were selected from fifty-four of the public schools of Baltimore and represent a distribution of race, sex, and economic status proportional to that of the city as a whole. Average age on initial examination was eight years. Approximately 500 children were chosen by audiometric screening tests and placed in a study group. After complete ear, nose, and throat examination, the children were divided equally into a treated and a control section by random alternation. Irradiation was administered with a standard 50-mg. anhydrous radium sulfate applicator, screened with 0.3 mm. of Monel Metal. Three

treatments were given, spaced two weeks apart. The control group received the same type of exposure with blank applicators. Following the initial examination few children received a second course of irradiation. Any child who showed progressive deterioration in hearing acuity was removed from the study and referred to his private physician or to a local clinic.

The results of this investigation confirm previous observations. When employed within the limits described by Crowe and Burnham (Ann. Otol., Rhin. & Laryng. 50: 15, 1941), irradiation of lymphoid tissue

with the standard type of radium applicator has proved a safe form of therapy. It has been found to be beneficial in patients suffering from recurrent otitis media and a reversible conductive type of hearing loss. It is not recommended for the removal of large central adenoid masses or for the treatment of other types of deafness.

[For a later report, giving more detailed results of treatment, the reader is referred to an article by Hardy and Bordley (Ann. Otol., Rhin. & Laryng. 63: 816, September 1954)—Ed.]

RADIOISOTOPES

Observations on the Calculation of Thyroid Weight, Using Empirical Formulae. Frank J. Kelly. J. Clin. Endocrinol. & Metab. 14: 326-335, March 1954.

It is important to be able to calculate the weight of the thyroid gland when estimating the amount of radioactive iodine to be given for treatment of hyperthyroidism. Attempts have been made to develop an objective method of calculating thyroid weight in clinical subjects. After mapping-out the contours of the thyroid with the scintillation counter (scintigrams), the weight calculation commonly used employs this empirical equation: Weight of each lobe = Maximum height in cm. \times Surface area in $\text{cm}^2 \times K$, in which K is a constant supposedly relating the height of a lobe to its third dimensional projection, taking into account the density of thyroid tissue. To test the accuracy and validity of this method, the present study was undertaken.

Fifteen patients whose thyroid glands were outlined by the scintillation counter after administration of radioactive iodine were studied. In 13 the thyroid gland was weighed after surgery; in the other 2, at necropsy. In 16 additional cases studied at necropsy, in which iodine had not been given, the thyroid, trachea, and larynx were removed in one piece and, after the strap muscles were trimmed away, the anterior *visual* outlines of the thyroid were made and from these the maximum height and surface area were measured. The weight of each lobe was then calculated.

In the first group of 15 patients the calculated weights were always in excess of the actual weights, the extremes being 6.2 to 147.6 per cent, with a mean positive error of 49 per cent. In the second group, variations were both positive and negative, the extremes of error being +74 per cent and -38.9 per cent, with a mean of +9.7 per cent. The anterior *visual* outline is smaller than the anterior scintigram, since while the eye cannot, of course, see through the trachea, the scintillation counter can detect gamma rays coming from the posterior portions of the gland as well as the anterior.

The author has found no accurate correlation between the height of the thyroid lobe on the scintigram or outline, the surface area, or the product of height \times surface area and the actual weight of the thyroid gland. The assumptions upon which the empirical equation are based are found not to be valid.

Some other problems of dose calculation are discussed. Six figures; 2 tables. JOHN F. RIESSE, M.D. Springfield, Ohio

Effect of Stress, TSH and ACTH on the Level of Hormonal I^{131} of Serum. Reginald A. Shipley and Frank H. MacIntyre. J. Clin. Endocrinol. & Metab. 14: 309-317, March 1954.

Nine patients, in a euthyroid state as indicated by twenty-four-hour thyroidal uptake of I^{131} , who were scheduled for surgery, received a dose of 100 microcuries of I^{131} two days before operation. Blood samples drawn twenty-four and thirty-six hours later served to establish the preoperative level of activity of the thyroxine fraction. Blood samples drawn at intervals of twenty-four and forty-eight hours after surgery were measured for thyroxine fraction activity in order to determine the effect of the stress of surgery on this hormonal level. To serve as controls, blood samples were taken from 10 non-surgical euthyroid patients daily for four days after a similar dose of I^{131} . A third group, consisting of 9 non-surgical patients, received an injection of 12 to 15 mg. of TSH (Armour) intramuscularly forty-eight hours after radioiodine administration. Blood studies were done as in the first groups. ACTH was given to a fourth group at forty-eight hours after I^{131} and similar determinations were made. The technic of the serum determinations is described.

Stress of major surgery (e.g., herniorrhaphy, subtotal gastrectomy) was accompanied by a rise in the level of the hormonal I^{131} of serum in 3 of 9 patients. A similar effect was produced by the injection of small doses of TSH in 5 of 9 normal subjects. ACTH did not influence the level.

The authors summarize: "The results are compatible with the concept that acute stress causes a release of thyroid hormone from the gland. Experiments reported by others indicate that an increased utilization of hormone by peripheral tissues also occurs. The present studies suggest, but do not conclusively prove, that the intensified thyroid activity is not solely a secondary response promoted by a declining blood thyroxine level, but may include an independent primary stimulation of the gland."

Three graphs; 1 table. JOHN F. RIESSE, M.D. Springfield, Ohio

RADIATION EFFECTS; PROTECTION

Damage to Posterior Caused by Irradiation of the Gonads. H. J. Muller. *Am. J. Obst. & Gynec.* 67: 467-479, March 1954.

In considering the damage to posterior from irradiation of human germ cells, the author points out that the frequency of mutation induced by radiation has been found to be proportional to the dose received. There is no valid evidence of a threshold dose and all doses must be considered as carrying some risk, proportional to their size. In addition, it has been found that it is the total accumulated dose, not its intensity or duration of application, which counts in determining the frequency of mutations received by the offspring. The only radiation having this influence is that absorbed by the gonads themselves. The susceptibility of the germ cells, in turn, depends on their stage of development.

"Mutations which do any damage at all may be regarded as equally harmful to the population and equally obnoxious, regardless of how drastically they affect a single individual inheriting them, since a smaller degree of effect on him is compensated for by the greater number of individuals affected."

It is no longer possible to doubt the conclusion that detrimental mutations are being produced in high numbers by such doses of radiation as are used for the instigation of ovulation, and that their frequency is indicated by present knowledge to be so high that the overall harm entailed by such a procedure exceeds its benefit. Judgments as to the benefit occurring from all other uses of ionizing radiation which involve exposure of the gonads require overhauling in the light of modern genetic findings, and the search for methods of reducing the exposure should be prosecuted actively.

THEODORE E. KEATS, M.D.
University of California, S. F.

Third Generation Follow-up of Women Treated by X-Ray Therapy for Menstrual Dysfunction and Sterility Twenty-eight Years Ago, with Detailed Histories of the Grandchildren Born to These Women. Ira I. Kaplan. *Am. J. Obst. & Gynec.* 67: 484-490, March 1954.

This study is based on results observed in 660 infertile women treated with high-voltage or low-dosage x-ray therapy over the past twenty-eight years; 270 such women who became pregnant were followed. To this group of women 347 entirely normal children were born. Thirty-four of these children were traced, and 20 of them were found to have produced 14 normal living children, that is, third-generation children, or grandchildren of the women originally treated.

The author concludes that irradiation, when properly used, is harmless to the treated woman and to her progeny's offspring. THEODORE E. KEATS, M.D.
University of California, S. F.

Fibromatosis and Fibrosarcoma Following Irradiation Therapy. Vernon D. Pettit, James T. Chamness, and Lauren V. Ackerman. *Cancer* 7: 149-158, January 1954.

The authors call attention to the rarity of documented cases of irradiation fibrosarcoma following roentgen therapy. They note, also, the frequent confusion of fibromatosis with fibrosarcoma and suggest that there may be a blending of the two.

Five cases are presented, 4 of fibrosarcoma and 1 of fibromatosis, each following roentgen therapy. The fibrosarcomas occurred twenty-eight years after irradiation to the neck for a goiter, five years after treatment of a retinoblastoma, nine years after treatment of a fibrosarcoma of the mandible, and eleven years after "having a lip cancer burned off." The case of fibromatosis appeared nine years after escharotic and irradiation therapy to the face for cancer of the nose. The authors feel that excessive roentgen therapy was given in each case. They suggest complete excision of an irradiation fibromatosis when it is first recognized.

Six photomicrographs. ROSS H. SMITH, M.D.
Mayo Foundation

Changes in Sternal Marrow Following Roentgen-Ray Therapy to the Spleen in Chronic Granulocytic Leukemia. William B. Parsons, Jr., Charles H. Watkins, Gertrude L. Pease, and Donald S. Childs, Jr. *Cancer* 7: 179-189, January 1954.

The purpose of this study was to determine the changes that occur in the sternal marrow of patients with chronic granulocytic leukemia who receive a course of roentgen therapy over the spleen. Aspiration biopsy of sternal marrow was performed before and immediately after a series of roentgen treatments in leukemic patients, and a differential cell count was done on material thus obtained. Daily leukocyte counts were obtained from peripheral blood smears. The height of the myeloid-erythroid layer of the centrifuged bone-marrow aspirate was considered a reliable index of marrow cellularity. An "absolute index" for each type of cell in the marrow was derived by multiplying the height of the myeloid-erythroid layer by the percentage of that particular cell in the differential count. The data were assembled from 12 cases and analyzed.

A significant decrease in the myeloid-erythroid layer was noted in 8 cases, no change occurred in 3 cases, and an increase of questionable significance occurred in 1 case. The mean value of the myeloid-erythroid layer before treatment was 40.7 and after treatment 25.4. This decrease in cellularity was considered indicative of an indirect effect of radiation upon the sternal marrow. The decrease in the cellular layer represented a fairly uniform decrease in all the cells of the granulocytic series.

The authors suggest that such an examination of bone-marrow smears before and after roentgen therapy may provide information that cannot otherwise be obtained, reflecting the progress of the disease more accurately than do the changes in peripheral blood.

Seven charts; 4 tables. ROSS H. SMITH, M.D.
Mayo Foundation

Fracture of the Femoral Neck as a Complication of Pelvic Irradiation. Frederick M. Smith. *Am. J. Surg.* 87: 339-346, March 1954.

The author considers fracture of the femoral neck following heavy pelvic irradiation to be an insufficiency type of fracture, similar to a march fracture, resulting from continued weight bearing on a hip weakened by the irradiation.

Characteristically these patients have pain sometime before the fracture line can be detected. When the fracture line is demonstrated, it is usually quite high in

the neck, with varying degrees of varus deformity. In the author's experience there is slight or no angulation in the lateral view. Conservative treatment or nailing results in a high percentage of bony union without aseptic necrosis.

Eight cases are reported here (6 in Negroes). The treatment factors are not given in very complete detail, but the dose does not appear to have been excessive, though in 2 cases specific mention is made of the use of lateral ports (which of course increases greatly the amount received by the femoral neck).

The average length of time between termination of radiation and demonstration of the fracture was thirty-four months (range one and one-quarter to four and one-half years).

Eleven roentgenograms; 16 drawings; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Carcinoma of the Larynx Occurring in a Patient Receiving Therapeutic Doses of I^{131} . E. R. King, William S. Cole, Alec Horwitz, and Calvin T. Klopp. *Arch. Otolaryng.* 59: 333-338, March 1954.

A case of primary carcinoma of the larynx, appearing eleven months after the initial administration of I^{131} (51 mc) for cancer of the thyroid, is reported. In the one-year period during which the patient was under study with I^{131} , she received a total of 178 mc of I^{131} , of which a total of 54 mc had been retained ninety-six hours following the respective doses. Determination of the retention of I^{131} was based on radioassays of urine.

The authors discuss the possibility that the intensive irradiation of the larynx and adjacent structures during the treatment of the thyroid may have been carcinogenic. The larynx and trachea received far more radiation from I^{131} than if the thyroid had been removed surgically.

While no conclusions can be drawn from a single case, it would appear that if irradiation of normal tissue is to be kept at a minimum, surgical ablation of the functioning thyroid tissue prior to treating metastases with I^{131} is to be favored over ablation of the gland by the isotope.

Two roentgenograms; 2 photomicrographs.

Results of a Check on Irradiation Protection by Means of Films. H. Langendorff and F. Wachsmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 80: 382-386, March 1954. (In German)

The Radiological Institute of the University of Freiburg and the Advisory Department for Irradiation Protection of the University of Erlangen have been sending out small film envelopes for a check on irradiation protection to any institution that wishes to partake in the survey. The films differ from those used in England and in the United States in that they contain a series of graduated filters, which make it possible to determine the quality of radiation. They are coated with a special emulsion of such sensitivity and quality that, from the curve of blackening, it is possible to read directly the exposure in percentages of the permissible weekly dose (the tolerance dose being 0.5 r per week).

Since 1951, 7,090 film envelopes had been sent out. Of these, 6,035, that is 86 per cent, could be evaluated. The others were either lost or improperly worn. In 79.8 per cent of the cases the exposure was less than 0.05 r, that is less than one-tenth of the tolerance dose. Two hundred and forty-four envelopes, that is 4 per cent, showed the tolerance dose to be exceeded. In

2.38 per cent the exposure was between 0.5 and 1.0 r, in 0.61 per cent between 1.0 and 2.0 r, and in 1.01 per cent over 2.0 r, reaching as much as 5, 10, and 20 r, and once even 50 r!

It seemed of interest to determine whether the transgression of the tolerance dose occurred only once, perhaps by accident, in the same person, or whether it was repeated. It was found that of 51 persons receiving an excess dose, 42 showed only an occasional transgression. Nine, however, were habitual offenders.

Radium workers showed eight times as many instances of overexposure as x-ray workers. Among the x-ray workers, those employed in purely therapeutic institutions showed a slightly higher number of over-exposures than those in purely diagnostic institutions. Large institutions doing an enormous amount of x-ray work showed only a slightly greater tendency to overstep the tolerance dose than smaller institutions.

The survey has already resulted in considerable improvement of the radiation protection in numerous installations, and it is expected that this type of study will eventually be routinely employed in most institutions.

Three graphs. W.M. A. MARSHALL, M.D.
Chicago, Ill.

Chronic Low-Level Exposures of Young Mice to Ionizing Radiations and the Effect on Fertility. Roberts Rugh. *J. Pediat.* 44: 248-257, March 1954.

Some 225 mice were exposed to low weekly doses of x-rays or radioiodine (subcutaneous injection) for forty-four weeks, beginning at the time of weaning, and were sample tested at monthly intervals for fertility. At the termination of the experiment, all gonads were examined histologically.

None of the males showed a statistically significant drop in fertility when compared with the controls. This applies equally to those exposed to weekly doses of 10 r x-rays, which aggregated 440 r, or of 4 microcuries of I^{131} , aggregating 176 microcuries. All surviving males tested at the termination of the experiment were fertile. The females in all categories, controls and experimentals, showed decreased fertility as compared with males.

Radioiodine at the dose levels used was not sterilizing with respect to the ovary, although with increasing doses there was a lowering of fertility. The overall fertility of females receiving I^{131} was 47 per cent, as compared with 73 per cent for the controls.

Whole body x-irradiation, 10 r per week for forty-four weeks, resulted in completely sterile ovaries in every instance. These mice were completely sterilized after the seventh month or following an accumulated exposure of 280 r. Many were sterile at an earlier stage (i.e., fifth month following 200 r). The overall fertility of all females over the eleven-month period was 22 per cent, as compared with 73 per cent for the controls.

It is concluded that beta, gamma, and x-rays are more damaging to the ovary than to the testes; that 10 r x-rays are more deleterious than 4 microcuries of I^{131} given weekly; that, when given at weekly intervals, an accumulated dose of 280 r x-rays appeared to be completely sterilizing for the female mouse, while 440 r of x-rays over forty-four weeks does not appreciably reduce male fertility.

Nine photomicrographs; 2 tables.

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